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Major article

Individual versus pooled multiple-lumen blood cultures for the diagnosis of intravascular catheter-related infections

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Key Words:
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Background: The current gold standard method for diagnosis of central-line associated bloodstream infections (CLABSIs) requires central venous catheter removal and a positive culture of the CVC tip with a positive peripheral blood culture.
Study design: Comparative study.
Methods: We compared individual blood cultures from each catheter lumen versus a pooled-blood culture bottle containing blood samples from every catheter lumen for the diagnosis of CLABSI.
Results: The pooled blood culture had the same sensitivity as the individually cultured central venous catheter lumens (85%) to detect CLABSI. A high correlation was found when we compared the pooled culture with any positive lumen result ($\kappa = 0.98$) but not when compared with any single lumen.
Conclusions: Sampling multiple lumens from a central line and incubating them in the same blood culture bottle is as effective as individual blood cultures for the diagnosis of colonization or CLABSI and is a better choice than sampling only 1 lumen when sending 3 different blood culture bottles is not possible.

In the United States more than 200,000 cases of central line-associated bloodstream infection (CLABSI) are estimated to occur each year, with an attributable mortality of 12%-25%.[1] The human and economic cost of these infections is substantial.[2]

The current gold standard method for diagnosis of CLABSI requires central venous catheter (CVC) removal and a positive culture of the CVC tip with a positive peripheral blood culture. A major drawback of this method is that more than 70% of the suspected CLABSI cases yield negative blood culture results, sometimes meaning that the CVC was unnecessarily removed.[3]

Several conservative methods have been investigated during recent years with the objective of improving CLABSI diagnostic accuracy and avoiding unnecessary removal of CVCs, which consequently reduces risks related to new CVC insertions.[4] A definite conservative diagnosis of CLABSI requires that at least 2 blood cultures be drawn (1 from a catheter hub and the other from a peripheral vein) that when further cultured meet CLABSI criteria for quantitative blood cultures or differential time to positivity.[5]

Contributing to the difficulty is that the number of CVC lumens needed to be cultured for an accurate diagnosis is unclear. Recent Infectious Diseases Society of America practice guidelines describe this as an "unresolved issue."[5] A retrospective study found that not drawing cultures from all of the CVC lumens can lead to a misdiagnosis rate of up to 37.3% in CLABSI episodes.[6]

Sampling each line of a triple-lumen CVC would require 4 blood culture bottles instead of only 2. Performing this in all probable CLABSI cases would increase the cost. On the other hand, not sampling them would underdiagnose up to one-third of cases and would surely increase the morbidity and length of stay by delaying proper treatment, all of which result in cost increases.

We compared the utility of blood culture for diagnosis of CLABSI when blood is obtained from multiple CVC lumens and inoculated in a single culture bottle (pooled) versus inoculated in different culture bottles.

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Conflicts of interest: None to report.

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Table 1
Results from the different blood cultures drawn from patients

Distal	Proximal	Medium	Any	Pooled	Peripheral	CVC tip
K pneumoniae	*K pneumoniae*	*K pneumoniae*	*K pneumoniae*	*K pneumoniae*	*K pneumoniae*	*K pneumoniae*
A baumannii	Neg	Neg	*A baumannii*	*A baumannii*	*C albicans*	*C albicans*
C albicans			*C albicans*	*C albicans*		
S aureus	*S aureus*	*S aureus*	*S aureus*	*S aureus*	*S aureus*	Neg
Neg	*C albicans*	Neg	*C albicans*	*C albicans*	Neg	Neg
S sapropyticus	*S saprophyticus*	NA	*S saprophyticus*	*S saprophyticus*	Neg	Neg
K pneumoniae	Neg	Neg	*K pneumoniae*	*K pneumoniae*	Neg	Neg
A baumannii			*A baumannii*	*A baumannii*		
Neg	Neg	*P aeruginosa*	*P aeruginosa*	*P aeruginosa*	Neg	Neg
		S maltophilia	*S maltophilia*	*S maltophilia*		
E faecalis	Neg	*K pneumoniae*	*E faecalis*	*E faecalis*	Neg	Neg
			K pneumoniae	*K pneumoniae*		
Neg	*E coli*	*P aeruginosa*	*P aeruginosa*	*P aeruginosa*	Neg	Neg
			E coli			
Neg	*K pneumoniae*	*E faecalis*	*K pneumoniae*	*K pneumoniae*	*E faecalis*	*E faecalis*
			E faecalis			
E coli	*P aeruginosa*	*P aeruginosa*	*E coli*	*E coli*	*P aeruginosa*	*E coli*
	E coli	*E coli*	*P aeruginosa*		*A baumannii*	
Neg	Neg	Neg	*S aureus*	Neg	Neg	*S aureus*
Neg	NA	Neg	*S aureus*	Neg	*S aureus*	*S aureus*
Neg	*C albicans*	Neg	*C albicans*	Neg	Neg	*S aureus*
			S aureus			
Neg	Neg	Neg	Neg	Neg	*S haemolytycus*	Neg
Neg	Neg	Neg	Neg	Neg	Neg	*S aureus*
Neg	NA	Neg	Neg	Neg	Neg	*S aureus*
Neg	Neg	Neg	Neg	Neg	Neg	*S aureus*
Neg	Neg	Neg	Neg	Neg	Neg	Neg
Neg	NA	Neg	Neg	Neg	Neg	Neg
Neg	NA	Neg	Neg	Neg	Neg	Neg
Neg	Neg	Neg	Neg	Neg	Neg	Neg
Neg	Neg	Neg	Neg	Neg	Neg	Neg
Neg	Neg	NA	Neg	Neg	Neg	Neg

A baumannii, *Acinetobacter baumannii*; C albicans, *Candida albicans*; *CLABSI*, central line-associated bloodstream infection; *CVC*, central venous catheter; E coli, *Escherichia coli*; E faecalis, *Enterococcus faecalis*; K pneumoniae, *Klebsiella penumoniae*; *NA*, not available because of blood clots; *Neg*, negative; P aeruginosa, *Pseudomonas aeruginosa*; S aureus, *Staphylococcus aureus*; S haemolytycus, *Staphylococcus haemolytycus*; S maltophilia, *Strenotophomonas maltophilia*; S saprophyticus, *Staphylococcus saprophyticus*.

METHODS

Study population

The study was performed at the University Hospital Dr José Eleuterio González, a 450-bed teaching hospital in Monterrey, Mexico. Between July 2012 and February 2014 we included adult patients with a CVC (double or triple lumen) or acute hemodialysis catheters who had a positive blood culture drawn from 1 of the CVC hubs and who retained the central line until the blood cultures became positive, at which time the medical team decided to remove the CVC. We excluded patients who retained the CVC by medical indication and eliminated patients for whom we were not able to sample at least 2 lumens of the CVC.

Culture techniques

After rigorous antiseptic cleansing of the skin and the hub with 4% chlorhexidine, we aseptically drew qualitative blood cultures from the CVC hub and simultaneously drew peripheral blood cultures by puncture technique. The order in which the hubs were sampled (ie, proximal, medial, or distal) was randomized before the blood was drawn. Patients with triple-lumen CVCs had 6 mL blood drawn from each lumen and 4.5 mL from each sample was inoculated into an individual blood culture bottle. The remaining 1.5 mL from each sample was then pooled into a single blood culture bottle (total volume of inoculum of pooled sample was 4.5 mL). In patients with a double-lumen CVC we drew 6 mL blood from each hub: 4.5 mL blood was inoculated to an individual culture bottle and the remaining 1.5 mL was placed in the pooled bottle, which at the end contained 3 mL; that is, 1.5 mL from each lumen. After all study blood cultures were drawn the CVC was removed and the tip was sent for semiquantitative culture using the roll plate method. We did not influence the treating medical staff's decision to reinstall a CVC or administer antibiotic treatment. The hospital staff was aware of the study but the staff did not have knowledge of the study's objective. Versa TREK REDOX I 40 mL blood culture bottles (TREK Diagnostic Systems, Cleveland, Ohio) were used for all blood cultures.[7] The bottles are designed for samples of 1.5 mL blood. The blood cultures were processed in a VersaTREK blood culture incubator system (TREK Diagnostic Systems).

Study definitions

Differential time to positivity >120 minutes was defined as a growth of microbes from a blood sample drawn from a catheter hub detected at least 2 hours before microbial growth was detected from a blood sample obtained from a peripheral vein. The same organism had to be isolated from both samples (peripheral and CVC).[5] Catheter colonization was defined as the growth of organisms in a blood culture obtained from a hub of the CVC or a positive CVC tip with a negative blood culture obtained from the peripheral vein.

Statistical analysis

We determined sensitivity, specificity, negative predictive value, and positive predictive value for both the pooled blood culture and the standard method individually for CLABSI and for colonization. We determined coefficient correlation concordance between the results by measuring the kappa index. We considered a kappa value $\geq$ 0.85 to be a significant correlation.