Review: Paired quantitative blood cultures most accurately detect intravascular device–related bloodstream infection

Safdar N, Fine JP, Maki DG. **Meta-analysis: methods for diagnosing intravascular device-related bloodstream infection.** Ann Intern Med. 2005;142:451-66.

Clinical impact ratings: Hospitalists ★★★★★☆ Infectious Disease ★★★★★☆ Critical Care ★★★★☆☆

QUESTION

Which tests are most accurate for diagnosing intravascular device (IVD)–related bloodstream infection?

METHODS

Data sources: MEDLINE (1966 to July 2004), *Current Contents* (1993 to July 2004), the Cochrane Library, conference abstracts, and bibliographies of relevant reviews.

Study selection and assessment: Studies of diagnostic tests for IVD-related bloodstream infection compared with a reference standard that provided data for calculating sensitivity and specificity. Quality assessment of individual studies included blinding of test interpretation and biases.

Outcomes: Sensitivity, specificity, likelihood ratios, and the equally weighted least-squares Q^* statistic (corresponds to the upper leftmost point on the summary receiver-operating characteristic curve, where sensitivity equals specificity).

MAIN RESULTS

51 studies on 8 frequently used diagnostic tests were included: qualitative catheter segment culture, semiquantitative catheter segment culture, quantitative catheter segment culture, IVD-drawn qualitative blood culture, IVD-drawn quantitative blood culture, paired quantitative peripheral and IVD-drawn blood cultures, acridine orange leukocyte cytospin testing of IVD-drawn blood, and differential time to positivity of concomitant qualitative IVD-drawn and peripheral blood cultures. Diagnostic performances of each test are in the Table. The most accurate tests were the paired quantitative blood cultures, IVD-drawn quantitative blood culture, and the acridine orange leukocyte cytospin test.

CONCLUSIONS

Paired quantitative peripheral and IVD-drawn blood cultures have the best diagnostic performance for detecting intravascular device–related bloodstream infection. Most other diagnostic tests have acceptable sensitivity and specificity.

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Diagnostic characteristics of tests for intravascular device (IVD)–related bloodstream infection*

Diagnostic test	Number of studies	Overall sensitivity (95% CI)	Overall specificity (CI)	+LR	−LR	Equally weighted least-squares Q^* (CI)
Paired quantitative blood cultures	10	87% (83 to 91)	98% (97 to 99)	44	0.13	0.94 (0.88 to 1.0)
Acridine orange leukocyte cytospin	5	72% (60 to 84)	91% (86 to 96)	8.0	0.31	0.89 (0.79 to 0.91)
IVD-drawn quantitative blood culture	7	77% (69 to 85)	90% (88 to 92)	7.7	0.26	0.89 (0.79 to 0.99)
Quantitative catheter segment culture	14	83% (78 to 88)	87% (85 to 89)	6.4	0.20	0.87 (0.81 to 0.93)
IVD-drawn qualitative blood culture	7	87% (80 to 94)	83% (78 to 88)	5.1	0.16	0.86 (0.80 to 0.92)
Semiquantitative catheter segment culture	19	85% (81 to 89)	82% (80 to 84)	4.7	0.18	0.84 (0.80 to 0.88)
Differential time to positivity	8	85% (78 to 92)	81% (75 to 87)	4.5	0.19	0.85 (0.81 to 0.97)
Qualitative catheter segment culture	6	90% (83 to 97)	72% (66 to 78)	3.2	0.14	0.76 (0.64 to 0.88)

*Diagnostic terms defined in Glossary; LRs calculated from data in article. Overall sensitivity and specificity were estimated using a random-effects model.

COMMENTARY

Bacteremia remains one of the most serious complications related to the use of intravascular catheters. Determining which patients' catheters are the source of bacteremia is challenging without the removal of the device. As a result, 80% of catheters removed for suspicion of infection are found not to be the source and thus were removed unnecessarily (1, 2). For this reason, attention has been focused on methods to diagnose catheter-related bloodstream infection (CR-BSI) without catheter removal. This is especially important for patients with long-term catheters who have poor vascular access.

Several methods exist to detect CR-BSI. In this meta-analysis, Safdar and colleagues have presented the best tests. They showed that paired quantitative blood cultures are the most accurate method to diagnosis CR-BSI in situ for long-term catheters. However, most other methods studied showed an acceptable sensitivity and specificity (> 75%) and high negative predictive value (up to 99% in most studies). In addition, the positive predictive value of all tests increased with a high pretest probability of having a CR-BSI. Not all studies in the meta-analysis excluded patients with low pretest probability of CR-BSI, thus the performance of some tests may be underestimated when applied only to patients with suspected CR-BSI.

The paired quantitative blood culture is not a test without drawbacks. Some organisms do not survive the lysis-centrifugation process).

It is also labor-intensive at the laboratory level, requiring several manipulations, and therefore the potential exists for contamination. It is expensive and not widely used in hospitals with heavy workloads and few technical staff members.

A practical approach to diagnosing CR-BSI in situ while taking advantage of the differential in organism load between the catheter and peripheral blood is the differential time to positivity. Most automated blood culture systems continuously monitor growth and now report positive readings every 10 to 20 minutes. If the differential time between the blood drawn through the catheter and the blood drawn peripherally is > 2 hours for each to turn positive, it is a sign that the organism load is higher in the catheter and that the catheter is probably the source of bacteremia. Using this method instead of quantitative cultures adds no additional laboratory cost, has similar sensitivity albeit lower specificity, and uses a blood culture system that is already in place at most centers.

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References
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