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Original article

Evaluation of the usefulness of a quantitative blood culture in the diagnosis of catheter-related bloodstream infection: Comparative analysis of two periods (2002 and 2012)

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ABSTRACT

Introduction: A retrospective study was conducted to investigate the usefulness of systematic quantitative blood culture (QBC) in the diagnosis of catheter-related bloodstream infection (CRBSI) during two 1-year periods (2002 and 2012).
Methods: The study included all QBC requests sent to the microbiology laboratory for suspected CRBSI in adults (≥18 years) with any type of intravascular catheter (IVC). Based on a ratio of ≥4:1 CFU/mL of the same microorganism between IVC blood culture from any lumen and peripheral blood culture, 5 diagnostic groups were defined: confirmed or probable CRBSI, primary BSI, other focus of infection, and colonization.
Results: In total, 4521 QBCs were evaluated; 24% positive in 2002 and 16% in 2012 ($P<0.0001$). There were 243 episodes of suspected CRBSI (101 in 2002 and 142 in 2012). Confirmed CRBSI episodes were higher in 2002 than 2012 (56% vs 34%) ($P<0.0001$), whereas colonization episodes were lower (18% vs 38%) ($P=0.0006$). Gram-positive cocci decrease in 2012 relative to 2002 (56% vs 79.7%) ($P=0.022$). Almost one-third (32%) of confirmed CRBSI would have been missed if blood from all catheter lumens had not been cultured.
Conclusions: QBC is a useful method for diagnosing CRBSI. Blood samples from all catheter lumens must be cultured to avoid missing around one-third of CRBSI diagnoses.

Evaluación de la utilidad del hemocultivo cuantitativo en el diagnóstico de la bacteriemia relacionada con catéter: análisis comparativo de dos periodos (2002 y 2012)

Palabras clave:
Hemocultivo cuantitativo
Bacteriemia
Bacteriemia relacionada con catéter
Catéter intravascular
Colonización

RESUMEN

Introducción: Se ha realizado un estudio retrospectivo, para investigar la utilidad del hemocultivo cuantitativo (HC) para el diagnóstico de las bacteriemias relacionadas con catéteres (BRC), durante dos periodos de un año (2002 y 2012).
Métodos: Todos los HC recibidos en el laboratorio de microbiología realizados ante la sospecha de BRC, a pacientes ≥18 años portadores de cualquier tipo de catéter intravascular (CIV), han sido incluidos en este estudio. Basándonos en la proporción ≥4:1 CFU/mL del mismo microorganismo entre el HC de cualquier luz del CIV y el HC periférico se han definido 5 grupos diagnósticos: BRC confirmada o probable, bacteriemia primaria, otro foco de infección y colonización.

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Resultados: Han sido evaluados 4521 HC; 24% positivos en 2002 y 16% en 2012 ($P < 0.0001$). Fueron sospechosos de BRC 243 episodios (101 en 2002 y 142 en 2012). El Porcentaje de episodios de BRC confirmados fue mayor en 2002 que en 2012 (56% vs 34%) ($P < 0.0001$), en cambio fue menor el de los episodios de colonización (18% vs 38%) ($P = 0.0006$). Los cocos Gram-positivos disminuyeron en 2012 en relación con 2002 (56% vs 79.7%) ($P = 0.022$). En el 32.2% de las BRC confirmadas se hubiese perdido el diagnóstico si no se hubiera realizado HC de todas las luces.

Conclusiones: El HC es un método muy útil para el diagnóstico de las BRC. Hay que obtener muestra de sangre de todas luces para cultivo con el fin de evitar la pérdida de alrededor del 30% de los episodios de BRC.

Introduction

Intravascular catheters (IVCs) are commonly used in most medical centers. These devices are not only applied in hospitalized and emergency patients for administration of intravenous fluids or medication, but also in outpatients. A great variety of IVCs are available and all types are susceptible to colonization by microorganisms. The incidence of catheter-related bloodstream infection (CRBSI) is estimated at 0.1 to 5/1000 catheter-days.[1–4] Once a long-term catheter is successfully placed, attempts are made to maintain it as long as it is needed, as replacement is not without risk and another suitable vascular access may not be available.

Three methods are currently used for diagnosing CRBSI without removing the IVC: quantitative blood culture (pour plate method),[5] semiquantitative blood culture (lysis-centrifugation),[6–9] and qualitative blood culture, using differential time to positivity on an automatic system.[7–10] Since 1988, quantitative blood culture (QBC) has been used in our center (sensitivity of 94%, specificity of 100%).[5] The aims of this study are to determine the usefulness of this technique in two different periods: that is, to know what percentage of QBCs enable a microbiological diagnosis of CRBSI, to ascertain the IVC colonization rate in our setting, and to determine the percentage of CRBSI diagnoses that would have been missed if QBC had not been performed in all catheters or lumens in patients using several devices or IVCs with 2 or more lumens.

Material and methods

A retrospective observational study investigating the usefulness of our QBC method for the diagnosis of CRBSI was carried out in Vall d'Hebron Hospital (Barcelona, Spain), a 1000-bed reference hospital within the publically-funded health system. Two years were analyzed and compared: 2002 and 2012.

Patients

The study included all QBC requests sent to the Microbiology Department for adult patients (≥18 years) using 1 or more IVCs, including 1-lumen or ≥2-lumen devices, multiple catheterizations, or Port-A-Cath (PAC) catheters. All culturing procedure protocols in which the IVC QBC was erroneously identified or peripheral blood culture was not carried out were excluded from the analysis.

Sample collection

In each patient, samples containing 1–3 mL of blood for QBC were taken through all the IVC lumens and placed in sterile tubes containing sodium polyanetholesulphonate as anticoagulant (SPS tubes, reference 745452, Imunohealth S.L. Alella, Barcelona, Spain). At the same time, a blood sample of >12 mL was drawn from a peripheral vein, 1–3 mL was inoculated in a QBC tube, and the remainder was placed in bottles for qualitative culture (aerobic and anaerobic medium, Bact/Alert 3D bioMérieux, Marcy L'Etoile, France). QBC follow-up of the CRBSI episodes was done only on samples from IVC lumens.

Quantitative method

For each QBC, 1–3 mL of blood was mixed with 20 mL of previously melted (water bath or microwave at defrosting position for 1 minute) brain heart infusion agar at ∼56 °C in petri plates. After letting the plates stand for 20 minutes at room temperature, they were incubated aerobically for 4 days at 35–37 °C. The remaining sample was stored at 5–7 °C. All QBCs were examined daily for growth. The number of colonies recovered was estimated using the rule of three calculation and expressed as colony-forming units per mL (CFU/mL). When the count was >1000 CFU/mL, QBC was repeated on a sheep blood agar plate using a 1:1000 calibrated loop with the stored blood to provide a more precise count. In addition, Gram staining was done. Subculturing was performed on sheep blood agar and selective medium according to the morphology of the organism observed on Gram stain. Conventional methods were used for the preliminary identification[11] and the Vitek 2 System (bioMérieux, Marcy L'Etoile, France) for definitive identification. Antimicrobial susceptibility was assessed according to the Clinical and Laboratory Standards Institute (CLSI) recommendations, using Mueller–Hinton agar (Kirby Bauer diffusion method) and Rosco disks (neo-Sensitab; Rosco Diagnostica, Taastrup, Denmark). The microorganisms isolated from the catheter(s) and peripheral blood were considered identical when the genus, species, biotype, and antibiotype coincided.

Definitions

Based on the ratio between the CFU/mL count of the same microorganism (species and antibiotype) isolated in the peripheral blood QBC and the QBCs from each different IVC lumen,[5] five groups were defined to classify each episode:

I. Confirmed catheter-related bloodstream infection: simultaneous QBCs in which the number of CFU/mL isolated from blood drawn from any lumen of the patient's IVC(s) was ≥4-fold the number isolated from peripheral blood.
II. Probable catheter-related bloodstream infection: QBCs in which the number of CFU/mL isolated from blood drawn from all lumens of the patient's IVC(s) was in no case ≥4-fold the number found on peripheral blood culture, but the same microorganism was simultaneously isolated on culture of purulent drainage at the insertion site or semiquantitative culture of a catheter tip using the Maki method (≥15 CFU).[12]
III. Primary bloodstream infection: QBCs in which the number of CFU/mL isolated from blood drawn from all lumens of the