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Major Article

Isopropyl alcohol is as efficient as chlorhexidine to prevent contamination of blood cultures

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Local

Background: False-positive blood cultures can lead to unnecessary risks and misuse of antibiotics; to reduce rates of false-positives, it would be useful to determine whether use of an antiseptic with a prolonged effect is required.

Methods: Clinical study of efficacy (blinded and randomized) to compare the rate of blood culture contamination when skin antisepsis was performed with 70% isopropyl alcohol or 2% chlorhexidine gluconate in 70% isopropyl alcohol in 2 hospitals. Patients aged 16 years or older with suspected bloodstream infection who were allocated in the emergency room, internal medicine ward, or intensive care unit were included.

Results: Five of 563 (0.9%) blood cultures from the isopropyl arm and 10 of 539 (1.9%) from the chlorhexidine arm were contaminated. No significant differences were observed among the rate of contamination ($\chi^2 = 1.27$; $P = .3$) or the relative risk of contamination (relative risk = 2.09; 95% confidence interval, 0.72-6.07; $P = .2$).

Conclusions: The rates of blood contamination were not different when isopropyl alcohol and chlorhexidine were compared. Isopropyl alcohol could be used for skin antisepsis before blood collection.

Bloodstream infections (BSIs) remain a major issue for health care institutions. In the United States alone, 30,000 BSIs are reported every year; furthermore, each episode has an average cost of $45,000 and an increase of 10 days in the length of hospital stay.[1,2] Physicians cannot diagnose a BSI without a positive culture[1]; then it is essential to the institution to have the infrastructure and procedures that ensure an adequate collection and processing of blood samples, and to reduce to the minimum the rate of false-positive cultures.

Every false-positive culture has a cost of $4,500-$10,000, because of the increase in the length of hospital stay and the unnecessary use of antibiotics.[3] Because operating costs of hospitals can significantly increase, hospitals should seek to eliminate false-positive cultures. Nevertheless, a zero rate is quite difficult to achieve, so a rate of <3% is nowadays recommended by the Clinical and Laboratory Standards Institute.[4] Several strategies to optimize blood collection and to prevent contamination have been described. The selection of an adequate antiseptic to perform the antisepsis for blood collection is important, because most of the contaminant organisms are part of the skin flora of the patient. Nowadays, it is recommended to perform the antisepsis with chlorhexidine gluconate because it has proven superiority against other antiseptic agents, such as povidone.[3,5-11] However, a discussion about which antiseptics to choose for skin antisepsis is ongoing. In a recent study, where false-positive blood cultures were obtained by venipuncture draw, no differences between chlorhexidine gluconate and isopropyl alcohol were observed. Of note, the chlorhexidine arm was compared against a historical control sample (isopropyl alcohol), so potential bias could happen.[12] The aim of this study is to compare the efficacy of chlorhexidine and isopropyl alcohol to prevent blood cultures contamination, using a 2-step disinfection method.

METHODS

Study design

A clinical study of efficacy (single blinded, randomized) was performed April 2011-May 2012. The study was reviewed and approved

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by the review board from the institutions involved, and was registered in ClinicalTrials.gov (No. NCT01361997).

Institutions

The Hospital General de Leon is a 210-bed secondary-care institution with an average of 700 nonobstetric discharges per month. The Hospital Regional de Alta Especialidad del Bajio is a 184-bed tertiary-care hospital without obstetric wards, with an average of 550 discharges per month. Both institutions are teaching hospitals and have committees for infection control.

Patients

Patients aged 16 years or older with suspected BSI treated in the emergency department, internal medicine ward, or intensive care unit. The suspicion of BSI was determined by at least 2 of the following: temperature >38°C or <36°C, heart rate >90 bpm, respiratory rate >20 bpm, arterial partial carbon dioxide <32 mm Hg, or blood leukocyte count >12,000 cells/μL or <4,000 cells/μL.

Intervention methods

When a patient with suspected BSI was admitted to the study, the antiseptic with which to perform the skin hygiene before blood collection was selected. For this purpose, the personnel in charge of blood collection had a set of sealed, shuffled cards from which a card was randomly selected. On the card, an antiseptic was encoded as substance 1 (70% [v/v] isopropyl alcohol [BD Alcohol Swabs; Becton, Dickinson and Company, Franklin Lakes, NJ], or substance 2 (2% [v/v] chlorhexidine gluconate in 70% isopropyl alcohol [ChloraPrep One-step Frepp applicator; Becton, Dickinson and Company]. This procedure had to be performed for each sample. To be included, the patient had to have a set of blood cultures taken, which consisted of at least 2 cultures from different sites and at least 1 had to be from a peripheral vein.

Technique of blood culture collection

Blood for cultures was drawn by nurses from the catheter care unit. They were trained to do the procedure as follows. Once the patient was correctly identified, and after hand hygiene, an initial antisepsis on the puncture site was performed with a swab impregnated with isopropyl alcohol with repeated back-and-forth strokes for 30 seconds, and was allowed to dry for 30 seconds as the manufacturer recommends. Afterward, now with sterile-gloves, a second antisepsis was performed with either a swab impregnated with isopropyl alcohol or chlorhexidine in the same way. For this second step, a prepackaged kit was used that included a pair or sterile gloves, the antiseptic, and a syringe. At least 5 mL blood had to be obtained for bottle inoculation. Bottle taps were decontaminated with isopropyl alcohol. For blood collection, the nurses were instructed to obtain the sample from the cubital fossa of the forearm. Blood collection technique was proposed by the infection control committee of the Hospital de Alta Especialidad del Bajio, and replicated in the Hospital General de Leon.

Microbiologic methods

Blood cultures were incubated for up to 5 days at 35°C ± 1°C in a BacT/Alert 3D system (BioMerieux, Marcy-l'Etoile, France). A microbiologist blinded to the study protocols determined the positivity of the blood cultures and performed the identification and the susceptibility test for the isolated organisms. A positive set of blood cultures was considered contaminated when any of the following organisms: coagulase-negative *Staphylococcus*, *Corynebacterium* spp, *Bacillus* sp, *Propionibacterium* spp, *Micrococcus*, or α-hemolytic viridans group streptococci, was recovered from 1 blood culture from the set of blood cultures, or when the same organism was not isolated from another potentially infected site.[3]

Statistics

To detect an absolute increase of 2%-4% in the rate of contamination of blood cultures, with a confidence of 95% and a power of 80%, a sample size of 483 blood cultures per arm was determined. Although central and peripheral cultures were taken, the analysis only addressed the peripheral cultures. Contamination rates were compared with χ^2 test and $P < .05$ was considered significant.

RESULTS

Overall, 1,102 sets of blood cultures were taken, in every case, a central and a peripheral sample was obtained. From the 1,102 peripheral blood cultures, 563 (51%) corresponded to the isopropyl alcohol arm, and 539 (49%) corresponded to the chlorhexidine arm. Regarding the allocation, 348 (32%) samples were obtained from the emergency department, 588 (53%) from the medicine ward, and 166 (15%) from the intensive care unit. From all cultures, 130 (12%) were true-positive, of which 50 (38%) were from the emergency department, 72 (55%) were from the medicine ward, and 9 (7%) from the intensive care unit (Table 1).

Overall, 14 of 1,102 cultures (1%) were considered to be false-positive, 10 (67%) of them belonging to the internal medicine ward and 4 (33%) to the emergency department. No false-positive blood cultures were found in the intensive care unit.

When the 2 arms of the study were compared, no significant differences existed in the proportion of false-positive blood cultures, both in the analysis divided for location and the pooled analysis (Table 2). Similarly, nonsignificant differences existed among the relative risk (RR) of false-positive cultures in the emergency department (RR, 3.9; 95% confidence interval [CI], 0.4-37.3; $P = .2$), the internal medicine ward (RR, 1.7; 95% CI, 0.5-5.9; $P = .9$), and the pooled sample (RR, 2.1; 95% CI, 0.7-6.1; $P = .2$).

Coagulase-negative staphylococci were the most frequent contaminating organisms in both study arms because they were

Table 1
Organisms isolated from true-positive blood cultures after skin disinfection with isopropyl alcohol or chlorhexidine gluconate in isopropyl alcohol

Organism	Isopropyl alcohol n (%)	Chlorhexidine gluconate n (%)
Staphylococcus aureus	4 (6)	4 (6)
MRSA	1 (25)	0
Coagulase-negative *Staphylococcus*	4 (6)	3 (5)
Enterococcus faecalis	4 (6)	2 (3)
Other *Enterococcus* spp	4 (6)	3 (5)
Streptococcus spp	1 (1)	1 (2)
Escherichia coli	32 (44)	22 (35)
ESBL	21 (66)	13 (59)
Klebsiella spp, *Enterobacter* spp	4 (6)	15 (24)
ESBL	0	1 (7)
Pseudomonas aeruginosa	8 (11)	3 (5)
Acinetobacter spp	1 (1)	4 (6)
Other nonfermenting gram-negative bacilli	2 (3)	2 (3)
Candida albicans	0	1 (2)
Other *Candida* spp	3 (4)	0
Other organisms	5 (7)	3 (5)
Total	72	63

NOTE. Values are presented as n (%).
ESBL, extended-spectrum β-lactamase; MRSA, methicillin-resistant *Staphylococcus aureus*.