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ORIGINAL RESEARCH

Taking blood cultures from a newly established intravenous catheter in the emergency department does not increase the rate of contaminated blood cultures

Anne-Maree Kelly and Sharon Klim
Joseph Epstein Centre for Emergency Medicine Research at Western Health, Sunshine Hospital, Melbourne, Victoria, Australia

Abstract

Objective: It has been suggested that blood cultures drawn from vascular catheters have a higher false positive rate than those drawn by venepuncture. In the face of institutionally imposed practice change prohibiting obtaining blood cultures from intravenous (i.v.) catheters in the ED, our aim of was to compare the rate of contaminated blood cultures between those taken from recently placed i.v. catheters and those taken by direct venepuncture.

Method: Prospective, non-randomised, observational study comparing the rate of contaminated blood cultures for specimens taken from recently placed (<1 h) i.v. catheters and direct venepuncture in adult ED patients. Outcome of interest was the rate of false positive cultures. Analysis was by comparison of proportions (χ^2-test).

Results: Four hundred seventy-two blood culture sets were studied. There were 65 positive cultures, of which 49 (75%; 95% confidence interval [CI], 63–85%) were classified as true positive. The overall rate of contaminated blood cultures was 3.4% (95% CI, 2.0–5.6%). There was no difference in false positive rate between blood cultures taken via venepuncture and those taken from a recently placed i.v. cannula ($P = 0.52$; odds ratio, 0.9; 95% CI, 0.33–2.44).

Conclusion: We found no difference in contaminated blood culture rate between recently placed i.v. catheters and direct venepuncture when infection control procedures were followed.

Key words: *blood culture, catheter, contamination.*

Introduction

Blood cultures can be an important tool in the care of patients with suspected sepsis. A positive blood culture can suggest a diagnosis, guide therapy and provide some indication of prognosis.[1] However, false positive blood cultures can result in unnecessary investigation or treatment and additional cost.[2,3] False positive blood cultures result from contamination; that is where organisms that are not actually present in the blood are grown in culture. Reported rates of contamination vary from less than 1% to over 7%.[3,4]

It has been suggested that blood cultures drawn from vascular catheters have a higher false positive rate due in part to catheter colonisation and catheter insertion processes.[5–9] Other studies have failed to show such an association.[10,11] Of particular importance, a recent study has suggested that blood cultures taken in the ED from

Correspondence: Professor Anne-Maree Kelly, JECEMR, Sunshine Hospital, Furlong Road, St Albans, Melbourne, Vic. 3021, Australia. Email: anne-maree.kelly@wh.org.au

Anne-Maree Kelly, MD, FACEM, Professor, Director; Sharon Klim, BN, Research Coordinator.

peripheral intravenous (i.v.) catheters have almost double the rate of contamination compared with those taken by direct venepuncture (6.53% *vs* 3.56%).[12] In response, some institutions (including the study institution) have implemented procedures prohibiting the taking of blood cultures from all vascular catheters.

In the ED, many patients require a vascular catheter (usually a peripheral i.v. cannula) as part of their care. These vascular catheters have usually been placed immediately before bloods are drawn giving little window for colonisation to occur so, at least in theory, the risk of a false positive because of catheter colonisation should be low. Staff are reluctant to perform separate venepuncture to obtain blood cultures with its attendant pain for patients when a recently placed i.v. catheter is available. In the face of an institutionally imposed practice change, the aim of the present study was to compare the rate of contaminated blood cultures between those taken from recently placed i.v. catheters and those taken directly by venepuncture.

Methods

This was a prospective, non-randomised observational study of blood cultures taken in the ED of a community teaching hospital with an annual ED census of approximately 35 000 adult patients. Participants were all patients who had a blood culture ordered as part of their care between May and November 2010. Staff were instructed that they could collect blood for culture from a recently (<1 h) placed i.v. catheter or by venepuncture. The i.v. catheters placed by prehospital personnel (e.g. paramedics) were excluded. Hospital policy regarding sterility, skin cleansing and blood culture bottle preparation was followed for all patients. Staff were asked to indicate on the request form the site of sampling and whether it was taken from a catheter or via venepuncture. Samples without an identified site were excluded. All samples were handled and reported according to standard procedures by the hospital laboratory.

The outcome of interest was the rate of contaminated blood cultures for the two sampling methods. Determination of classification was performed according to accepted microbiological principles.[4,12] These included consideration of the identity of the organism, the number of positive culture sets, the number of positive cultures within a set, time to growth and quantity of growth. Cultures of *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *S. pyogenes*, *S. agalactiae*, *Listeria monocytogenes*, *Neisseria gonorrhoeae*, *Haemophilus influenza*, *Bacteroides fragilis*, *Cryptococcus neoformans* and *Candida* species were automatically classified as true positive. All other cases were subjected to medical record review by a clinician blinded to method of sampling to determine their classification.

Data were analysed by descriptive statistics, χ^2 analysis and Fisher's exact test for comparison of proportions and odds ratio. We were informed by the institutional infection control team that the previous rate of contaminated blood cultures was approximately 5%. Sample size estimation showed that to detect a doubling in contaminated culture rate (i.e. 10% *vs* 5%) with alpha of 0.05 and power of 80% would require study of approximately 680 blood cultures. The study was terminated before the target was reached as resources for data collection were no longer available and because of a change in pathology service provider.

The study was approved by the institutional ethics panel as a quality assurance project. Specific patient consent was not required.

Results

Data from 666 blood culture tests were obtained. After exclusions for missing data, the final sample studied was 472. Sample derivation and results are shown in Figure 1. There were 65 positive cultures, of which 49 (75%; 95% confidence interval [CI], 63–85%) were classified as true positive. The overall rate of true positive cultures was 10.4% (95% CI, 7.9–13.5%). The overall rate of contaminated blood cultures was 3.4% (95% CI, 2.0–5.6%).

There was no difference in false positive rate between blood cultures taken via venepuncture (3.6%; 95% CI, 1.7–7.2%) and those taken from a recently placed i.v. cannula (3.2%; 95% CI, 1.5–6.5%; $P = 0.52$). Odds ratio for contaminated culture for blood taken via i.v. cannula was 0.9 (95% CI, 0.33–2.44).

To assess whether blood cultures with missing site would have altered the results, a Fisher's exact test was performed comparing the venepuncture group, the i.v. cannula group and the group with unknown site. No statistically significant difference was found ($P = 0.97$).

Discussion

We found no statistically or clinically significant difference in contaminated blood culture rates between blood drawn from a recently placed i.v. cannula and that taken

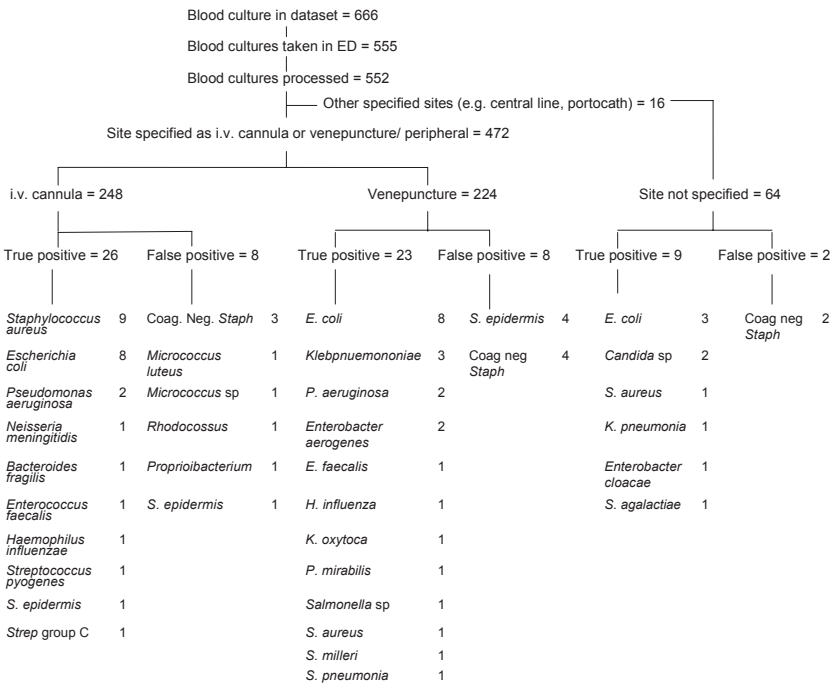

Figure 1. Sample derivation and results.

by direct venepuncture. This finding is somewhat at odds with other ED studies[8,9,12] and the ICU-based study investigating cultures drawn from a newly established central line,[5] all of which showed higher contamination rates in samples drawn from catheters. There are a number of possible explanations for these differences. Infection control policies and procedures relating to blood culture draws might differ between the institutions. Insertion of central vein catheters requires direct manipulation of the catheter itself, albeit under supposedly sterile conditions, unlike insertion of a peripheral i.v. catheter. Norberg *et al.*[9] identified young children as being a risk factor for blood culture contamination. This might relate to technical issues with skin preparation, blood draw and handling in patients who are small and unable to cooperate. We were unable to identify other similar studies in an adult sample such as ours.

The overall contaminated culture rate (3.4%) was in the mid-range of reported rates[4] and approaches the goal rate suggested by Self *et al.* of 3%.[13] Unlike sites in some other countries, the study ED does not have technician phlebotomists to take blood specimens. It is reliant on nursing staff to perform this task. Although most nursing staff are permanent staff members with training in local infection control policies and procedures, a proportion are sourced from external agencies to fill roster gaps. Their training and awareness of local practices vary. Given the time pressure, workload, environmental and staff turnover issues of ED, this is probably an acceptable result.

We limited our study to i.v. catheters that had been placed within 1 h of blood culture draw. Our rationale was that this gave minimal time for contamination. It was also the duration acceptable to our ethics panel. It is possible that the low contamination risk window is longer than 1 h. Given the convenience and speed of blood draws via existing cannula in the busy ED environment, this might be worthy of further study.

It is possible that our results are simply a reflection of good infection control practices with respect to blood draws for blood cultures. In April 2010 a revised procedure for obtaining blood cultures was introduced at the study institution emphasising hand hygiene for the collector at multiple steps in the procedure, sterile technique and skin antisepsis for the patient. This procedure was followed whether blood was drawn from an i.v. cannula or venepuncture. This change might have resulted in the reduced contamination rate compared with historical levels irrespective of sampling method.

A recent quality improvement study in the United States has reported reducing the contamination rate from 4.3% to 1.7% (95% CI, 1.4–2%) by implementing a quality improvement programme including the taking of all specimens by direct venepuncture and the use of sterile gloves,

materials kit (containing a 2% chlorhexidine skin antisepsis device, a sterile fenestrated drape and a sterile needle) and a procedural checklist.[13] This rate is considerably lower than that achieved in either arm of our study. A possible explanation is a Hawthorne effect on implementation of procedures because of the active nature of the quality improvement project.

The present study has some limitations that should be considered when interpreting the results. Although we aimed for a consecutive sample, some cases were missed because of staff forgetting about the study or the workflow demands of a busy ED. This also resulted in the sample size analysed falling below that calculated in our sample size estimation. That said, the contaminated culture rates were so similar that it would require a very large number of samples to identify a statistically significant difference. Post hoc sample size estimation found that to detect a 1% difference (3–4%) would require in excess of 8000 samples. Our study was a non-randomised, observational design. This might have resulted in staff choosing one sampling method over the other for reasons we did not investigate. Given that the proportion of samples taken by each method is similar, we expect any bias to be small. The study was conducted in a single ED so results might not be generalisable to other ED. The infection control policies and procedures of the study institution might have influenced the low rate of contaminated cultures. Different policies and procedures regarding blood culture collection might yield different results. Classification of blood culture result as true or false positive was performed by a single clinician (albeit blinded to collection method) and was reliant on review of medical records that have well-known problems with data omissions.[14] Although classification was based on accepted microbiological principles, some subjective assessment was required in some cases.

In conclusion, we found no difference in contaminated blood culture rate between recently placed i.v. catheters and direct venepuncture when infection control procedures were followed. Our results do not support the requirement for blood cultures to be taken from a separate venepuncture when a recently placed i.v. catheter is available.

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Competing interests

A-MK is a member of the editorial board of *Emergency Medicine Australasia*.

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