

Laboratory Findings Associated With Positive Blood Cultures In Patients Using Intravascular Catheters

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Abstract

*The use of intravascular catheter puts patients at risk for catheter-related bloodstream infection (CR-BSI). Laboratory diagnosis of CR-BSI involves blood culture and tip culture. The microorganisms detected in positive blood culture and tip culture need to be evaluated whether they are true pathogens or contaminants. The purposes of this study are to analyse the microbiological profile of positive blood culture and tip culture in patients using intravascular catheter. Furthermore, this study also compares the result of non refrigerated and refrigerated tip cultures to infer the value of performing routine tip culture. This study uses secondary data on blood culture and tip culture which were collected during the period of January to May 2009 from AusLAB database. Experimental study of refrigerated tip cultures using Maki method was also performed to support the analysis on tip culture. All data are analysed using descriptive analysis method. In this study, a total of 168 microorganisms were isolated from 150 positive blood cultures from 86 patients. The most common bacteria detected in blood samples were *S. epidermidis* (18.45%). To infer CR-BSI among patients, a total of 67 tips from 65 patients were analysed. Of the 67 tips, 40 tips (60.45%) showed no growth. The concomitant result of blood culture and tip culture is used to assume the probability of CR-BSI among patients; and it was showed that only 3 probable CR-BSI were found. Furthermore, the refrigerated tip culture result showed that most of refrigerated tips (76.05%) yielded the same result as the primary tip culture. Hence, refrigeration does not cause significant change. In assisting laboratory diagnosis of CR-BSI, tip cultures can be refrigerated until the positive blood culture result is confirmed. Considering the limitations of tip culture, the clinical usefulness of performing routine tip cultures need to be evaluated further.*

GENERAL INTRODUCTION

The use of intravascular catheters has been unavoidable in a modern medical practice, particularly for critically ill patients. They are used for the administration of medication such as antibiotics, chemotherapy, fluid and nutrition, and for haemodialysis. In general, intravascular catheter either venous or arterial catheter can be used for short-term or long-term access.¹

Although such catheters provide necessary vascular access, their use puts patients at risk for local and systemic complications, for example, local site infection and systemic catheter-related bloodstream infection (CR-BSI). It is estimated that 250,000 to 500,000 episodes of intravascular devices (IVD)-related bloodstream infection occur in the USA annually. Systemic catheter-related infections remain among the top three causes of nosocomial infection with mortality up to 25%. Moreover, such infections cause an increased duration of hospital stay and medical expenses.^{1,2,3}

Placement of intravascular catheter is one of the risk factors associated with bloodstream infection. Other factors that predispose an individual to bloodstream infection are age and underlying diseases, for example, malignancies, renal failure requiring dialysis, immune deficiency syndrome, and conditions associated with the loss of normal skin barriers such as severe burns.⁴

According to Maki et al. (2006) all types of intravascular devices create a risk of systemic CR-BSI.⁵ Pathogenesis of systemic CR-BSI involves microorganisms which colonise either extra luminal or intra luminal surface of the device then disseminate through blood circulation. The other source of systemic intravascular device-related infection is contamination of the fluid administered through the device and is known as infusate-related infection.⁶

Establishing diagnosis of systemic CR-BSI involves both clinical and laboratory components. The most common clinical

manifestations associated with CR-BSI, for example, fever with or without chills are not specific and not sensitive; moreover, signs of local inflammation (such as erythema, tenderness or induration) around the intravascular device have poor sensitivity. Therefore, laboratory diagnosis is necessary to provide microbiological evidence implicating the catheter as a source of bloodstream infection.^{1,2,3}

Blood culture is considered the gold standard for diagnosing bloodstream infection. The culturing of blood for pathogen can provide important interpretative information. However, the presence of microorganism in the blood does not always represent true bacteremia or bloodstream infection. Nearly half of all positive blood cultures represent contamination.⁷

Contamination is common during the blood collection procedure and contaminants are probably introduced from the patient's skin, health care worker's hand or contaminated disinfectant during the procedure of intravascular catheter insertion.^{6,8} Regarding the interpretation of clinical significance of potential contaminant detected in blood culture, coagulase negative staphylococci (CoNS) are the most problematic group. Most CoNS are contaminants of blood cultures but they are as pathogens in 12 to 15% of blood isolates.⁹ As contaminants, CoNS come from the skin surface or catheter colonization. However, it has been studied that CoNS have been considered as the most frequent cause of CR-BSI and bacteremia in patients using vascular and other prostheses.^{7,8,10}

Making the determination of a true pathogen causing systemic CR-BSI is sometimes a vexing problem because the best method for diagnosis of systemic CR-BSI does not exist.³ It is widely accepted that laboratory methods for diagnosis of systemic CR-BSI include blood culture and catheter segment culture. Systemic CR-BSI can be established when blood culture and catheter segment culture (tip culture) reveal the same organism from a patient with accompanying clinical symptoms and signs of bloodstream infection

and no other apparent source of infection is detected.^{1,3,6,11}

Much research has been done to evaluate the clinical utility of performing tip culture in assisting the diagnosis of systemic CR-BSI. Considering that the origin of pathogen causing CR-BSI may be intraluminal or extraluminal, appropriate diagnostic technique is required. Inadequate or inappropriate method performed can give false positive or false negative result.¹² Therefore, in interpreting the result of tip culture and in determining the clinical significance of microorganism, many factors should be assessed carefully including the diagnostic method, the result of blood culture and clinical features of the patient. Apart from that, performing tip culture can increase the microbiology laboratory workload and it is recommended that tip culture is not performed routinely but is performed only when patients are suspected having CR-BSI.^{12,13} According to Bouza et al (2009), refrigeration of the tips can be an alternative way to reduce the workload in the microbiology laboratory without misdiagnosing CR-BSI.¹³

The purpose of this study is to analyse the microbiological profile of positive blood cultures and to analyse the result of tip cultures from patients using intravascular catheter. Furthermore, the result of 24-hour tip culture or without refrigeration (primary culture) and the result of tip culture after 5 days or more of refrigeration are also compared in this study to infer the utility of performing tip culture in assisting the laboratory diagnosis of catheter-related bloodstream infection.

MATERIALS AND METHODS

Study Design and Data Collected

Both non experimental and experimental study were conducted in this study. Non experimental study, which is based on secondary data, is used to analyse the microbiologic profile of blood culture and tip culture. Data on blood culture and tip culture were collected from AusLAB database. The data which were collected during the period of January to May 2009 are included in this study.

Experimental study was performed in the central microbiology laboratory of Pathology Queensland. Catheter segments (tips) that have been refrigerated at 4°C for 5 days or more were assigned randomly to be recultured. The identification result of the colony growing on the blood agar will be a primary data and then is compared to the result of the primary culture (secondary data). Both primary and secondary data are used together in the analysis.

Study Population

Data on blood culture and tip culture collected from patients using intravascular catheter, either arterial catheter or central venous catheter (both tunnelled and non-tunnelled) are analysed. Those blood and tip samples were sent to the laboratory to confirm or to rule out catheter-related bloodstream infection.

The catheter tips admitted for study were all distal tip portions which were sent to the laboratory and were examined after 5 days or more of refrigerated storage.

Culture Method and Interpretation

The refrigerated tips were recultured using Maki's roll-plate technique. This technique was performed by rolling the tips back and forth across the surface of blood agar for 4 times. Then, the blood agar was incubated at 35°C (hot room) for 24 hours. The tip isolates were determined by assessing the colony morphology, Gram stain and several standard bench tests and VITEK-2 identification system. The reporting system of the positive isolates is based on the standard local procedure.

Data Analysis

All qualitative data are analysed using descriptive analysis method.

RESULTS

1. Demographic characteristic of the patients

A total of 150 positive blood cultures which were obtained from 86 patients are analysed. The patients were hospitalized in different public hospitals, e.g. Royal Brisbane

and Women's Hospital, Royal Children's Hospital, Redcliffe Hospital, Caboolture Hospital, Logan Hospital and Redland Hospital as shown in Figure 1. All samples then were sent to the central Laboratory Pathology Queensland.

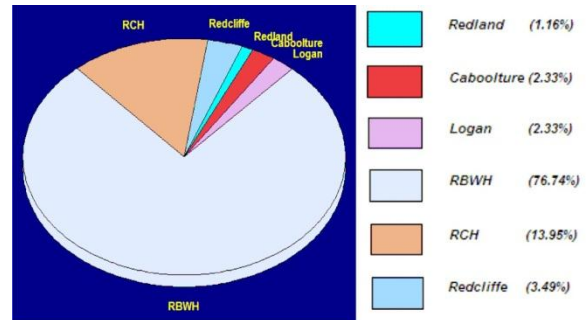


Figure 1. The patient distribution based on the hospitals

As many as 22 patients (25.58%) are patients at Intensive Care Unit (ICU patients) and 64 patients (74.42 %) are non ICU patients who were treated at various wards (general medicine, acute, burn unit, oncology, orthopaedic, clinical haematology, general surgery and gastroenterology unit).

According to Figure 2, of the 86 patients, most are elderly people which accounts for nearly above 40%. The youngest patient is 8 months old and the oldest is 85 years old.

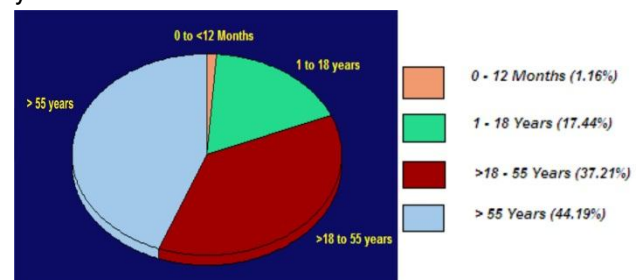


Figure 2. The age distribution of the patients

2. Microbiological profile of positive blood cultures

A total of 168 microorganisms were detected from 150 blood cultures, because single microorganism was isolated from each of 132 blood samples and two types of microorganisms were detected in each of 18 blood cultures (Table 1).

Table 1. Distribution of bacterial isolates cultured

Types of Isolates (microorganisms)	Number of positive cultures	Number of microorganisms
Single	132	132
Two types	18	36
Total	150	168

The pattern of microorganisms cultured from blood samples shows that the majority (54.76%) were Gram positive bacteria with *Staphylococcus epidermidis* is the most common bacteria isolated (18.45%) whereas Gram negative contributed 42.26% in total. *Klebsiella pneumoniae*, which accounts for 10.12%, is the second most common bacteria isolated among all isolates. Fungi or yeast were rare isolated, only contributed almost 3% in total (Table 2).

Table 2. Types of organisms cultured from blood samples

Organisms	N	%	
Gram positive	<i>Bacillus sp</i>	3	1.79
	Coagulase negative staphylococci	11	6.55
	<i>Corynebacterium sp</i>	4	2.38
	<i>Enterococcus faecalis</i>	7	4.17
	<i>Enterococcus faecium</i>	4	2.38
	<i>Lactococcus lactis</i>	1	0.60
	<i>Listeria monocytogenes</i>	1	0.60
	<i>Staphylococcus aureus</i>	4	2.38
	<i>Staphylococcus capitis</i>	5	2.98
	<i>Staphylococcus epidermidis</i>	31	18.45
	<i>Staphylococcus haemolyticus</i>	9	5.36
	<i>Staphylococcus hominis</i>	3	1.79
	<i>Staphylococcus warneri</i>	4	2.38
	<i>Streptococcus mitis</i>	3	1.79
<i>Streptococcus orali</i>	2	1.19	
Gram negative	<i>Acinetobacter baumannii complex</i>	5	2.98
	<i>Acinetobacter lwoffii</i>	2	1.19
	<i>Bacteroides fragilis</i>	2	1.19
	<i>Capnocytophaga sp</i>	2	1.19
	<i>Chryseobacterium (Flavo) indolegens</i>	1	0.60
	<i>Enterobacter cloacae</i>	6	3.57
	<i>Escherichia coli</i>	7	4.17
	<i>Haemophilus influenzae</i>	1	0.60
	<i>Klebsiella oxytoca</i>	4	2.38
	<i>Klebsiella pneumoniae</i>	17	10.12
	<i>Pseudomonas aeruginosa</i>	11	6.55
	<i>Pseudomonas putida</i>	2	1.19
	<i>Pseudomonas stutzeri</i>	1	0.60
	<i>Proteus mirabilis</i>	1	0.60
	<i>Sphingobacterium spiritovorum</i>	1	0.60
<i>Stenotrophomonas maltophilia</i>	8	4.76	
Fungi/Yeast	<i>Aspergillus fumigatus</i>	1	0.60
	<i>Candida albicans</i>	1	0.60
	<i>Candida glabrata</i>	1	0.60
	<i>Candida parapsilosis</i>	1	0.60
Unidentified yeast	1	0.60	
Total	168	100	

The microbiological profile of blood isolates is also compared between ICU patients and non ICU patients. As many as 48 microorganisms were isolated from ICU patients and 120 microorganisms were cultured from non ICU patients' samples. *Staphylococcus epidermidis* was the most common bacteria isolated from both group, ICU and non ICU patients, as many as 20.83% and 17.50%, respectively. The second most common bacteria isolated among ICU patients was *Pseudomonas aeruginosa* (10.42%) while among non ICU patients, *Klebsiella pneumoniae* was predominant which contributed 11.67% in total.

3. Analysis of the result of tip cultures in relation to positive blood cultures in assisting the laboratory diagnosis of systemic catheter-related bloodstream infection (CR-BSI)

Data on tip cultures were analysed among 86 patients with positive blood cultures.

Only in 10 cases, the same microorganism in tip and blood culture was cultured (Figure 3).

Tip culture was performed after its removal from febrile patient to help determine if the patient has a catheter-related bloodstream infection. Patients are suspected to have CR-BSI if from blood culture and tip culture can reveal the same organism.

The tip culture used semi-quantitative roll-plate method described by Maki. According to Maki method, the microbiological result of catheter tip culture is considered as significant colonisation which can infer catheter-related infection when the colony growth is ≥ 15 CFU and as insignificant colonisation when the colony growth is fewer than 15.¹²

According to Table 3, of the 10 cases, 9 cases are considered to have catheter colonisation because the colonies growing on the tip were equal or higher than 15 CFU and 1

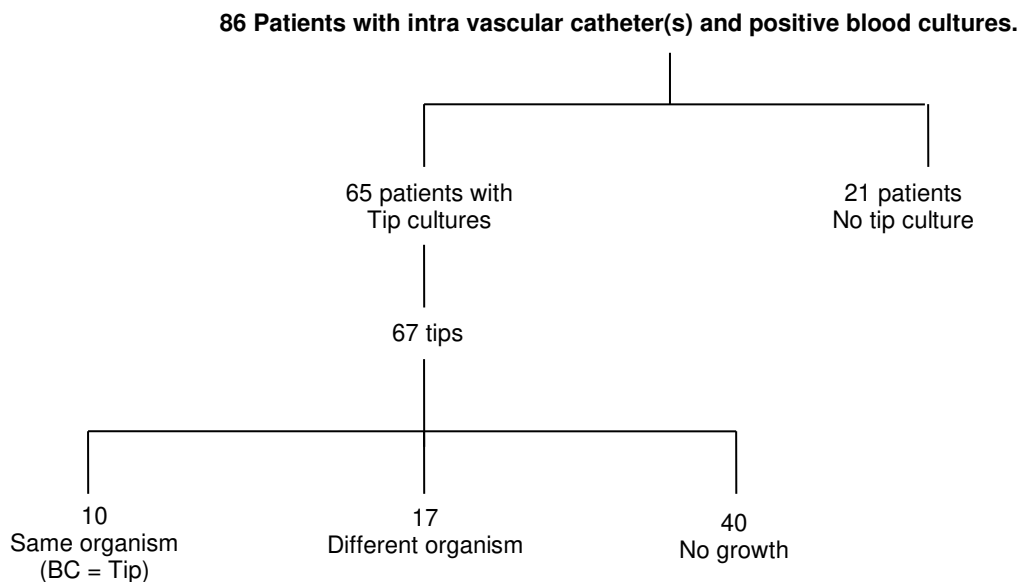


Figure 3. The tip culture result among patients with positive blood cultures

Of the 86 patients, only 65 patients who had data on tip culture. As many as 67 tips were cultured from 65 patients. From the 67 tips cultured, most tips (40 tips) were no growth and 17 tips grew different microorganism from blood

case has colony growth fewer than 15 CFU (no significant growth). Among 9 cases, 3 cases are probable CR-BSI because the same microorganism are detected in blood culture (both peripheral blood and catheter-drawn blood

or just in peripheral blood) and tip culture. The microorganisms which are probably causing CR-BSI in those 3 cases are *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Klebsiella pneumoniae*. Six cases are possible catheter-related bloodstream infection or catheter colonisation. Gram negative bacteria are more common than Gram positive detected in tip culture. *Klebsiella pneumoniae* is the most common microorganism which was found in 3 tips (30%) while fungi (*Candida glabrata*) is only found in 1 tip culture.

In group of 15 patients with 17 tip cultures, the tips have different microorganism from the blood culture. The most common microorganism detected in tip culture from this group is mix normal skin flora which accounts for 47.01% (8 tips out of 17 tips). This phenomenon suggests that probably the catheter is not the source of bloodstream infection

According to Figure 3, of the 65 patients with positive blood culture, 61.54% (40 tips) had no growth on tip culture.

A lot of studies have been conducted to evaluate the usefulness of performing routine tip culture along with blood culture on patients with febrile or septicemia related to intravascular catheter use. Regarding the high workload and higher cost in performing routine tip culture, Bouza et al. (2009) and Smuszkiwicz et al. (2009) recommended that routine tip culture is discontinued.^{12,13} According to Bouza et al. (2009), catheter tips can be refrigerated before culturing until positive blood culture is confirmed.¹³

4. *Analysis of the result of tip cultures after 5 days or more of refrigerated storage compared to the result of the primary culture.*

With regard to the refrigeration of catheter tips, in this study, the microbiological

Table 3. Types of same microorganisms detected in positive blood culture and tip culture from patients with catheter

No	Blood sample collected	Tip sample	Organism	CFU
1	Intravascular catheter	tip central line	<i>Acinetobacter baumannii complex</i>	15-50
2	• Intravascular catheter • Peripheral vein	tip CVC	<i>Staphylococcus epidermidis</i>	>100
3	Intravascular catheter	tip PICC	<i>Klebsiella pneumoniae</i>	15-50
4	Intravascular catheter	tip Portacath	<i>Candida glabrata</i>	>100
5	Intravascular catheter • Intravascular catheter	tip PICC	<i>Klebsiella pneumoniae</i>	>100
6	• Peripheral vein	tip Portacath	<i>Staphylococcus aureus</i>	15-50
7	Peripheral vein	tip PICC	<i>Klebsiella pneumoniae</i>	15-50
8	Intravascular catheter	tip PICC	<i>Enterococcus faecalis</i>	>100
9	Intravascular catheter • Intravascular catheter	tip central line	<i>Acinetobacter baumannii complex</i>	50-100
10	• Peripheral vein	tip central line	<i>Pseudomonas aeruginosa</i>	<15

Table 4. Comparison between primary and refrigerated tip culture results

Same result	Refrigerated tip culture (After 5 day- or refrigeration)	Number of tips	%
Primary tip culture (no refrigeration)			
No growth	No growth	52	73.24
Candida sp > 100 CFU	Candida sp > 100 CFU	1	1.41
Staphylococcus epidermidis 50-100 CFU	Staphylococcus epidermidis 50-100 CFU	1	1.41
Different result between primary and refrigerated tip culture with non significant growth		17	23.94
Total catheter tips		71	100

profile of refrigerated tip culture were compared to that of primary tip culture. This experimental study is aimed to infer the less usefulness of performing routine tip culture.

The tips which have been stored at cold room for 5 days or more then were recultured randomly. As many as 71 tips were recultured using semi-quantitative roll-plate method described by Maki and then were compared to the data on primary culture result. Most tips recultured yielded the same result as the primary culture which accounted for 76.06% (54 tips) as shown in Table 4.

DISCUSSION

Blood culture is a gold standard for diagnosis of bloodstream infection. Regardless of the source of the infection, bloodstream infection is a serious clinical condition which needs appropriate therapy. Faced with positive blood culture results, clinicians and microbiologist must determine whether the microorganisms represent clinically significant infection or represent a false positive result of no clinical consequence.

Interpretation of positive blood cultures for patients with intravascular devices in place sometimes is perplexing because while these individuals are at risk for bacteremia or catheter-related bloodstream infection, such results may also indicate culture contamination or colonisation of the catheter.¹⁴

The identity of microorganism in positive blood culture can aid microbiologist and clinicians in deciding whether a blood isolate is a pathogen or a contaminant. Weinstein et al. (2003) have studied that microorganisms that are should almost always be thought to represent true bacteremia include *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli* and other members of *Enterobacteriaceae*, *Pseudomonas aeruginosa* and *Candida albicans*. Furthermore, Weinstein's personal observation is that *Streptococcus pyogenes*, *Streptococcus*

agalactiae, *Listeria monocytogenes*, *Neisseria meningitidis*, *Neisseria gonorrhoeae*, *Haemophilus influenzae*, members of the *Bacteroides fragilis* group and *Cryptococcus neoformans* always represent true infection.⁷

On the other hand, certain organisms have been found to represent contamination such as coagulase negative staphylococci, *Corynebacterium sp*, *Bacillus sp* other than *B. anthracis*, *Propionibacterium acnes*, *Micrococcus sp*, viridans group streptococci, enterococci, and *Clostridium perfringens*.^{14,15}

Based on Table 2, the most common microorganisms detected in positive blood cultures in this study is coagulase negative staphylococci (CoNS). The difficulty in determining the clinical significance of these isolates comes from their being part of the normal skin flora. Therefore, they are most often contaminant in positive blood cultures which contribute 70% to 80% of all contaminated blood cultures.^{7,14}

Until 1975, CoNS were grouped together as *Staphylococcus albus* or *S. epidermidis*, distinguished from *S. aureus* by their inability to clot blood plasma. Most of CoNS isolated from humans belong to the *S. saprophyticus* group or to the *S. epidermidis* group, which includes the species *S. epidermidis*, *S. capitis*, *S. hominis*, *S. haemolyticus*, *S. warneri*, *S. caprae*, *S. saccharolyticus*, *S. pasteurii*, and *S. lugdunensis*.¹⁶ CoNS were often referred to as apathogenic staphylococci and the role as a true pathogen is still being debated.

However, during the past few decades, the importance of CoNS as human (predominantly nosocomial) pathogens has been recognized. In the early 1980s CoNS were recognised as important pathogen causing endovascular infection, catheter related bacteremia and bacteremia in patients with vascular and other prostheses.^{7,16,17} Soevenir et al. (1998) found that among 81 episodes of coagulase-negative staphylococcal blood

culture results, the incidence of clinically significant bacteremia was 20 (24.7%) episodes, that of indeterminate bacteremia was 10 (12.3%) episodes, and that of contamination was 59 (72.8%) episodes. Other studies found rates of true bacteremias ranging from 10% to 26.4% when CoNS are isolated from blood cultures.¹⁸

In this study, the most common species isolated from positive blood culture are *Staphylococcus epidermidis*. As a member of CoNS, *S. epidermidis* are usually skin microorganisms and are leading cause of CR-BSI as well as contaminated blood cultures. Costa and co-workers (2006) cited in Raad et al. (2007) have suggested that the nasal mucosa rather than the central venous catheter (CVC) is the major source of CoNS colonisation.² In patients with CVC, the catheter can be colonised by microorganisms embedded in a biofilm matrix. *Staphylococcus epidermidis* is the most common microorganisms isolated from catheter biofilm as well as *K. pneumoniae*, *S. aureus*, *Candida albicans*, *P. aeruginosa*, and *Enterococcus faecali*.¹⁹ According to Souvenir et al. (1998), *S. epidermidis* is responsible for 50-70% of catheter-related infections.¹⁷

Admittedly, judging the clinical significance of blood isolate is essential because it can have a profound impact on the clinical management of the patient. Unfortunately, a gold standard for differentiating true pathogen from contaminant does not exist. The identity of the microorganism cannot be used solely to determine the clinical significance of the blood isolate. Other factors that can be used as clues in interpreting the positive blood culture including clinical features of the patient, the proportion of blood culture sets positive as a function of the number of sets obtained, time to growth, quantity of growth, multiple organisms isolated and source of blood culture.^{7,14}

The isolation of two types of microorganisms from 18 positive blood cultures (Table 1) may indicate contamination or poor

site preparation. True bloodstream infections are almost caused by an infection with a singular microorganism. However, true bloodstream infection can be caused by many microorganisms or polyclonal microorganisms.¹⁴ Therefore, the presence of multiple microorganisms in a positive blood culture bottle does not merely represent contamination.

In determining the cause of bloodstream infection in patients with intravascular catheter in place, the source of blood specimen is important to be considered. The information about the type of blood sample collected can help microbiologist in deciding whether the blood isolate is an etiologic agent of CR-BSI or a contaminant from the catheter colonisation. McBryde et al. (2005) found that catheter-collected samples are not a good test for detecting true CR-BSI because samples taken through the catheter can yield false positive result.²⁰ A catheter-drawn sample inevitably retrieve microorganisms from catheter lumen so that a single positive blood culture of blood drawn through the line can indicate intraluminal colonisation or hub contamination rather than a true bloodstream infection.^{7,21}

A good correlation between catheter tip colonisation and CR-BSI has been found by Rijnders et al. (2002).²² Catheter tip colonisation can be used as 'surrogate end point for CR-BSI'.²² Hence, catheter colonisation is more likely to be the source of bacteremia or bloodstream infection in febrile patients with intravascular catheter in place. Nevertheless, CR-BSI is only confirmed if catheter colonisation is associated with a positive peripheral blood culture revealing the same microorganism.^{2,3}

Much research has been done to evaluate the accurate method for diagnosing CR-BSI. The roll-plate semiquantitative method is the most common method to assist the laboratory diagnosis of CR-BSI by culturing catheter segment (tip culture). A colony count of 15 CFU/ml or more is significant to cause catheter related infection. This significant colony

growth and in accordance with the positive peripheral blood culture will confirm the infection.

Most CR-BSIs are caused by microorganisms that colonise either outer surface of the catheter or inside of the lumen. Extraluminal colonisation occurs from migration of microorganisms from the skin along the subcutaneous tract while intraluminal colonisation occurs from contamination of the hub or infusate.^{6,23} In this study, *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Klebsiella pneumoniae* are the probable causes of CR-BSI detected in 3 cases. According to Goede and Coopersmith (2009), the microbial profile of CR-BSI is important for determining the appropriate therapy and predicting the ultimate outcome from the disease.²³ The most common microorganisms causing CR-BSI are coagulase negative staphylococci, *Staphylococcus aureus*, Gram negative bacilli and *Candida albicans*. It has been reported that Gram negative bacillary CR-BSI are commonly caused by *Klebsiella pneumoniae*, *Enterobacter sp.*, *Pseudomonas sp.*, *Acinetobacter sp.* and *Stenotrophomonas maltophilia*.² According to Rijnders et al., (2002), a certain degree of catheter tip colonisation due to *S. aureus* or *Candida sp.* may have a stronger predisposition to CR-BSI than would the same level of catheter colonisation due to *S. epidermidis*.²² Furthermore, different materials of catheter may have different risk of CR-BSI for a given level of colonisation.

Regarding the result of tip cultures that are mostly no growth and different growth from blood cultures in this study, it is necessary to consider that the source of CR-BSI can be intraluminal or extraluminal catheter colonisation.^{6,21} In addition, the technique used is semi-quantitative roll-plate which can take samples only from the external surfaces of the catheters and may not retrieve microorganisms that are may be strongly held inside the lumen of the catheter. Hence, the result of tip culture

can be false negative or reveal different microorganism.

The usefulness of performing catheter tip culture has been evaluated in several studies. A study of 238 CVC tips according to the Maki method was performed by Smuszkiewicz et al. (2009) and found that colonisation of CVC tips is rarely as a cause of CR-BSI.¹² According to Smuszkiewicz et al. (2009), tip culture with Maki method has a limit of value in diagnosing CR-BSI due to relatively low positive predictive value (PPV).¹² According to Bouza et al. (2007), more than 50% of catheter tips cultured in the laboratories are found to be negative.²⁴ Other studies revealed that as many as 36.7% tip cultures are reported as colonisation only from Sherertz et al., 1997 cited in Bouza et al., 2009 and 1.6% to 8.2% are colonisation and causing CR-BSI from Maki et al., 1977 cited in Bouza et al.(2009).^{13,24}

Due to the limitation of the method, performing tip culture with Maki method as a routine procedure is not recommended.¹² Most of the results are negative and it can suggest that the bloodstream infection is not associated with the use of intravascular catheter or because of intraluminal colonisation as mentioned before.

Performing tip cultures as a routine laboratory procedure for diagnosing CR-BSI can be costly. Bouza et al. (2009) recommended that catheter tips can be refrigerated until positive result of blood culture has been confirmed.¹³ Refrigeration of catheter tips will reduce laboratory workload and additional cost. Furthermore, refrigeration process does not give a significant impact on the yield of the microorganisms; hence, will not misdiagnosing CR-BSI.^{12,13}

Regarding the limitation of Maki method in assisting diagnosis of CR-BSI, Raad (1998) suggested that the semi-quantitative roll-plate method is less useful for examination the long-dwelling silicone catheters which have predominant luminal colonisation. A meta-

analysis study by Safdar et al. (2005) about the methods for diagnosing CR-BSI found that semi-quantitative roll-plate method with 2 blood cultures (1 peripheral blood and 1 catheter blood) will allow accurate diagnosis of CR-BSI in patients with short-term intravascular catheter while paired quantitative blood culture is the most accurate test for diagnosis CR-BSI in patients using long-term intravascular catheter.³ Other new diagnostic culture techniques are still being developed to provide better method with better sensitivity and specificity.

CONCLUSION

Interpreting positive blood culture result is challenging, particularly in patients with intravascular catheter, who are at risk for catheter-related bloodstream infection (CR-BSI). Determination of clinical significance of blood isolates needs comprehensive evaluation of other factors such as clinical features of a patient.

Catheter tip culture with Maki method is performed to provide microbiological evidence implicating catheter as a source of infection in assisting laboratory diagnosis of CR-BSI. However, due to the limitations of the method, the result of tip culture can be inaccurate and misleading. Considering the laboratory workload and the cost, it is recommended that tip culture is only performed when positive blood culture is confirmed. Refrigeration is an alternative way to overcome the high workload in the laboratory provided that refrigeration does not influence the yield of the microorganisms awaiting the result of the blood culture is established.

Despite the limitation of this study design, this study can give information about the microbiological profile of the positive blood culture and tip culture in patients using intravascular catheter. Further study with an appropriate study design and larger population can be conducted to determine the clinical significance of positive blood culture and to

asses the clinical utility of tip culture in assisting the diagnosis of CR-BSI.

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