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ORIGINAL ARTICLE

The rate of blood culture contamination and common organisms isolated in Malaysian public hospitals

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Abstract

Introduction: Blood culture contamination remains a dilemma issue in the diagnosis of bloodstream infection. However, to date, there is no national data on blood culture contamination and the common organism isolated in Malaysia. This is a pioneer multi-centre study involving public hospitals with medical microbiologists in Malaysia to determine the blood culture contamination rate and the common organism isolated. *Materials and Methods:* This retrospective cross-sectional study involved record review of all blood culture results over 9 months period from 1st January 2018 until

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30th September 2018 in 27 government hospitals in Malaysia. For each positive culture result, the type of isolated organism was classified to represent true bacteraemia or contamination. *Results:* We analysed 448,109 blood culture records from the participating hospitals. The blood culture positivity rate was 12.5% (57395 of 448109) and 25.0% (14367 of 57395) of the positive blood culture represents contamination. The national blood culture contamination rate in Malaysia was 3.2%. The contamination rate in the adult population was significantly higher than the paediatric population (3.6% vs. 2.6%; $p<0.001$). The blood contamination rate by institution ranged from 1.5% to 6.8%. The most frequently isolated microorganisms in the contaminated cultures were coagulase-negative staphylococci (71.0%). *Conclusion:* Blood culture contamination is a major issue that warrants priority in recognition, and interventions should be implemented to reduce the blood contamination rate in Malaysia.

Keywords: Blood culture contamination, contaminant, organism, public hospital, Malaysia

INTRODUCTION

Bacterial infection is a clinically significant cause of health loss globally. The epidemiology of bloodstream infection (BSI) is variable depending on the population and co-morbidity. In a Canadian study involving patients admitted to multidisciplinary intensive care units (ICU), BSI and BSI-associated septic shock accounted for about 6.0% and 3.0% of all admission to ICUs with in-hospital mortality rates of 40.0% and 49.0% respectively.[1] Blood culture remains vital and gold standard testing to provide a definitive diagnosis for patient's treatment. Clinical and Laboratory Standards Institute (CLSI) defined blood culture as a specimen of blood that is submitted for bacterial or fungal culture irrespective of the number of bottles or tubes into which the specimen is divided or distributed.[2]

Unfortunately, false positive blood cultures which were mainly due to blood contaminations remained a major issue globally including in Malaysia. A blood culture contaminant is defined as a microorganism isolated from a blood culture that was introduced into the culture during specimen collection or processing and that was not pathogenic for the patient from whom the blood was drawn.[2] Common contaminants are skin commensals such as *Coagulase Negative Staphylococcus* (CONs), *Micrococcus* species, *Propionibacterium acne* and *Diphtheroids*.[3] Meanwhile, environmental contaminants mainly the gram-positive bacilli such as *Bacillus* species except for *Bacillus anthrasis*, and the anaerobic *Clostridium* species were also associated with blood contamination.[4] Nevertheless, in recent studies, these organisms are an increasing source of true bacteraemia in patients with prosthetic devices and central venous catheters.[5]

In most institutions and health care settings, based on the American Society for Microbiology (ASM) and the CLSI recommendation, the acceptable blood culture contamination rate is less than 3.0%.[2] Actual studies showed the blood culture contamination rate ranged from 0.9-7.9%.[6-9] Higher blood contamination rates were expected in lower-middle-income countries such as Ghana and South Africa.[10-12] Contaminated blood culture has been associated with adverse outcomes for patients, and laboratories and a profound increase in costs to healthcare institutional.[8,13] Contaminated blood culture resulted in an increased one day of hospitalization for patients in the Emergency Department prior to admission[6] and was also associated with 5.4 days increase in in-hospital stay.[14]

To date, there is no published data on national blood culture contamination rate in Malaysia. This study was conducted as a pioneer multi-centre study in Malaysian public hospitals to determine the blood culture contamination rate as a benchmark for Malaysian standards of reference. In order to get the baseline blood culture contamination rate in Malaysia, data in the pre-COVID-19 era was used. The blood culture results during the COVID-19 era, which started in 2019, peaked in 2021 and attained endemic in 2022, may not reflect the true blood culture contamination rate as more COVID-19 related hospital admissions during the pandemic phase leading to lack of healthcare personnel, need of wearing full protection personal equipment, and higher workload for the healthcare providers may contribute to the change in blood culture contamination rate. Understanding the prevalence of blood culture contamination and common contaminants could navigate towards future development of interventions and recommendations to improve and reduce blood culture contamination in Malaysia.

MATERIALS AND METHODS

This observational cross-sectional study involved retrospective record review of all blood culture analysed over 9 months period from 1st January 2018 until 30th September 2018 in 27 government hospitals in Malaysia. Out of the 51 government hospitals with in-house medical microbiologists in Malaysia, 27 government hospitals across the 13 states and one federal territory agreed to participate in this study. The participating hospitals include Hospital Tuanku Fauziah, Hospital Tuanku Ja'afar, Hospital Tuanku Ampuan Najihah, Hospital Raja Permaisuri Bainun, Hospital Taiping, Hospital Teluk Intan, Hospital Serdang, Hospital Kajang, Hospital Sungai Buloh, Hospital Tengku Ampuan Rahimah, Hospital Putrajaya, Hospital Raja Perempuan Zainab II, Hospital Tanah Merah, Hospital Sultan Ismail Petra, Hospital Sultanah Nur Zahirah, Hospital Kemaman, Hospital Tengku Ampuan Afzan, Hospital Melaka, Hospital Pulau Pinang, Hospital Sultanah Bahiyah, Hospital Sultan Abdul Halim, Hospital Kulim, Hospital Sultanah Aminah, Hospital Segamat , Hospital Pakar Sultanah Fatimah, Hospital Umum Sarawak and Hospital Queen Elizabeth.

All the blood culture bottles received in the microbiology laboratory were incubated immediately in the automated blood culture machine either the BacT/Alert system (Biomerieux) or BD Bactec™ Blood Culture System. All blood cultures underwent standard incubation and processing per standard recommendation from the manufacturers for 5 days and were declared negative if no growth was detected by then. In the case of a positive blood culture flagged by the automated blood culture machine, an immediate Gram stain was performed, and the result was informed to the treating physician. Subsequently, the blood was inoculated on a suitable culture plate as per protocol. The culture plate was read after 24 to 48 hours. Identification of the microorganism was performed using manual and automated biochemical methods.[2]

Contaminated blood culture referred to single positive blood culture that was taken from either a central or peripheral source (labelled as blood culture or peripheral blood culture) which grew common contaminant organisms such as CONS, *Micrococcus* sp., *Bacillus* sp., *Diphtheroids* sp. and *Propionibacterium acnes*, or blood culture which grew mixed growth with more than 3 types of organisms.[3-4,14] The microbiology laboratory data of the blood culture results were extracted from the database which was available in the laboratory information system in the respective 27 public hospitals and transcribed into the pretested electronic data collection form. Permission from the respective hospital directors and head of pathology departments were obtained prior to data collection.

This study was approved by Medical Research Ethical Committee (22-01346-UVS (1)).

A total of 448,109 blood cultures collected from both in-patients and out-patients were included for analysis in this study. All blood cultures performed between 1st January 2018 and 30th September 2018 as recorded in the laboratory information system of microbiological laboratory in the participating hospitals in Malaysia with clinical microbiologists were included. Exclusion criteria included blood culture received in Myco/F Lytic culture vials or study sites that refused participation in this study.

The data were collected and analysed using an Excel sheet. The blood culture contamination rate was calculated by dividing the total number of contaminated blood cultures by the total number of blood cultures collected during the study period. The blood culture contamination rate for each respective participating hospital and the overall blood culture contamination rate which was referred as the national blood culture contamination rate were presented descriptively as numbers and percentages. The comparison of blood culture contamination rate between the adult population (13 years and above) and paediatrics population (12 years and below) was performed by using Chi-square test using Statcalc software (Epi Info™ 7.2.4.0, CDC). A *p value* of <0.05 was deemed significant. The common organisms isolated from contaminated blood cultures were presented descriptively by frequency and percentage.

RESULTS

The total blood culture samples received from both in-patient and out-patient settings in 27 participating microbiology laboratories between 1st January 2018 and 30th September 2018 were 448109 samples. One of the participating hospitals was unable to provide data on the number of true positive samples by age. Out of the remaining 26 participating hospitals, 79.8% (324643 of 406621) of blood cultures were received from the adult population (13 years and above) while 20.2% (81978 of 406621)

were received from the paediatrics population (12 years and below).

The blood culture positivity rate during this study period was 12.8% (57395 of 448109). From the total positive blood culture, 25.0% (14367 of 57395) represent blood culture contamination. The overall blood contamination rate was 3.2% (14367 of 448109) (Figure 1). The highest blood contamination rate recorded was 6.8% and the lowest contamination rate was 1.5%. The prevalence of blood contamination rates by each hospital was shown in Table 1 and the prevalence of blood contamination rates by adult or paediatric group was shown in Table 2. The contamination rate in the adult population was significantly higher than in the paediatric population (p value <0.001).

The most frequently isolated microorganisms in the contamination groups were CONs (71.0%), followed by *Bacillus* sp. (15.3%), *Diphtheroid* (7.7%), *Micrococcus* sp. (1.2%) and *Propionibacterium acnes* (0.2%) (Table 3). In addition to these organisms, 4.6% of blood contaminations were contributed by the mixed growth of more than 3 types of organisms.

DISCUSSION

Blood culture contamination remains a major pitfall despite its diagnostic role in the diagnosis of bloodstream infection. Blood culture contamination contributes to adverse clinical consequences, unnecessary costs and direct effects on analytical testing and laboratory efficiency.[8,13,15-16] In this current study, the national blood culture contamination rate in Malaysia was 3.2% (14367 out of 448109) which is higher than the standard benchmark sets by CLSI (2.0-3.0%).[2] Of the 27 participating hospitals, more than half (55.0%) of the participating hospitals achieved a blood contamination rate of >3.0%.

In this study, blood culture contamination in the adult population is 3.6%. This is lower as compared with a local study in a single northern Malaysian public hospital, which demonstrated a blood contamination rate of 6.4%,[17] and another local study in North-eastern Malaysia in 2011, where 8 years of annual blood contamination ranges from 2.7-6.5%.[18] Nevertheless, the blood culture contamination rate in Malaysia was comparable or even lower as opposed to certain other Asian countries.[19-20] On the contrary, a 4 years retrospective study in Japan showed a lower median blood contamination rate than in Malaysia (2.8%).[21]

For the paediatric population, our study demonstrated a 2.6% blood contamination rate which was lower in comparison to 7.7% in a single-centred study done in a local tertiary general hospital in Malaysia in 2016.[22] It is also lower as compared to 4.1% in a study performed in Indonesia.[23] Min H *et al.* performed a study in a single paediatrics institution in Korea and reported a blood culture contamination rate of 1.2% among the paediatric population with a higher contamination rate among younger children as compared to older children (2.1%, 1.0%, and 0.6% in children aged <1 year, 1-6 years, and >6 years).[24]

From this study, the most frequently isolated microorganisms in the contaminated cultures

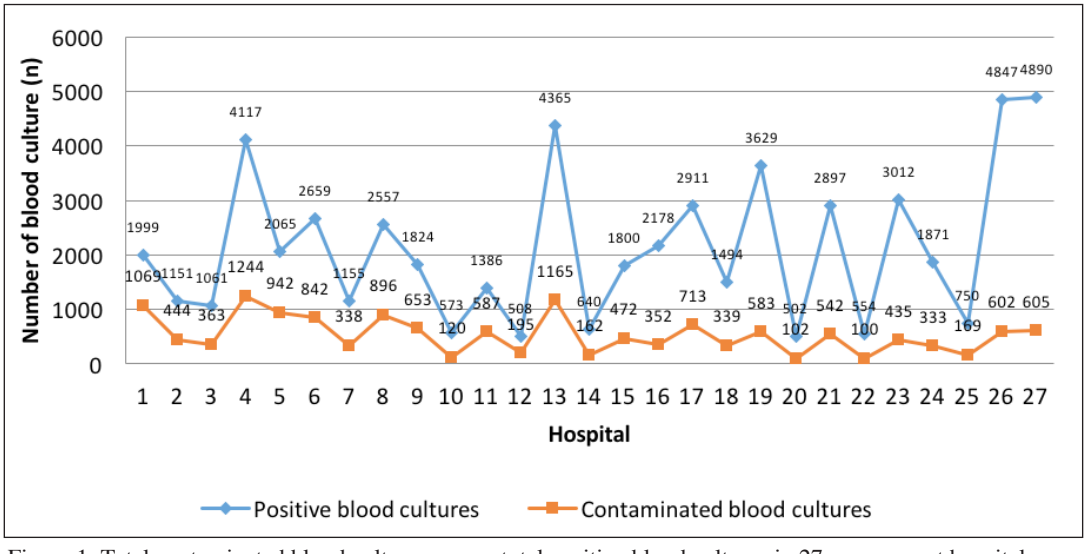

Figure 1: Total contaminated blood cultures versus total positive blood cultures in 27 government hospitals

Table 1: Blood culture contamination rate in 27 participating hospitals

Hospital	Total contaminated blood cultures (n)		Total contaminated blood cultures (n)	Total blood cultures received (n)	Blood culture contamination rate (%)
	Adult	Paediatric			
1	1031	38	1069	15638	6.8
2	422	22	444	7255	6.1
3	345	18	363	7058	5.1
4	1136	108	1244	25562	4.9
5	700	242	942	20633	4.6
6	739	103	842	19132	4.4
7	272	66	338	7896	4.3
8	708	188	896	22203	4.0
9	466	187	653	16751	3.9
10	94	26	120	3174	3.8
11	520	67	587	15826	3.7
12	137	58	195	5321	3.7
13	822	343	1165	33140	3.5
14	142	20	162	4854	3.3
15	372	100	472	15160	3.1
16	330	22	352	12126	2.9
17	670	43	713	24823	2.9
18	311	28	339	12230	2.8
19	527	56	583	22633	2.6
20	72	30	102	4105	2.5
21	469	73	542	22415	2.4
22	78	22	100	4375	2.3
23	345	90	435	19734	2.2
24	326	7	333	15405	2.2
25	116	53	169	8347	2.0
26	521	81	602	40825	1.5
27	486	119	605	41488	1.5
Overall	**12157**	**2210**	**14367**	**448109**	**3.2**

were CONs (71.0%), and other skin colonisers such as *Diphtheroids* (5.0%), *Micrococcus* sp. (1.2%) and *Propionibacterium acnes* (0.2%). Our findings correspond with previous studies where CONs have been demonstrated as the most common contaminant. Suwanpimolkul G *et al.* in Thailand reported the most common contaminants were CONs (80.6%), followed by

Table 2: Comparison of blood culture contamination rate between adult and paediatric population in 26 participating hospitals (1 hospital could not provide data by age)

Variable	Blood cultures			x^2 statistic	*p* value
	Total	Contaminated, n (%)	Non-contaminated, n (%)		
Adult	324643	11672 (3.6)	312971 (96.4)	218.417	<0.001*
Paediatric	81978	2091 (2.6)	79887 (97.4)		

**p* value of <0.05 is considered as significant.

Table 3: Distribution of organisms isolated from contaminated blood cultures

Organisms	n (%)
CONS	10201 (71.0)
***Bacillus* species**	2193 (15.3)
Diphtheroids	1103 (7.7)
***Micrococcus* species**	178 (1.2)
P. acnes	30 (0.2)
Others*	664 (4.6)

*other = mixed growth of 3 types of organisms

Corynebacterium spp. (7.4%), and *Micrococcus* spp. (6.5%).[19] Our findings also correspond with a study in Saudi Arabia which demonstrated CONs as the most common contaminant (60.9%) followed by *Corynebacterium* spp. (other than *C. jeikeum*) (7.8%).[20]

Similarly, with the paediatrics population, a study in a single paediatrics institution in Indonesia also demonstrated CONs as the most common contaminant (90.5%) followed by *Streptococcus* spp. (5.7%), *Pseudomonas aeruginosa* (1.9%) and *Pseudomonas* spp (1.9%).[23] A study in the paediatrics emergency department by Weddle *et al*. also reported CONs as the most common contaminant (72.0%) followed by *Viridans streptococcus* (10.0%).[25] Meanwhile, in Korea, Min H *et al*. reported the most common contaminants among paediatric populations were *Staphylococcus epidermidis* (37.0%), CONs (21.0%), and *Micrococcus* spp. (12.0%).[24]

The blood culture contamination rate reported in this study ranged between 1.5-6.8%. The difference in blood culture contamination rate could be due to multiple factors. The pre-analytic aspect such as the type of disinfectant used and different practices in blood culture sampling could be associated factors that contributed to the blood contamination rates among participating hospitals.[26] Apparently, there are no single antiseptics that are superior to others. However appropriate use of disinfectant may reduce blood contamination rate.[27-28] CLSI recommends 2% chlorhexidine in 70% alcohol as a disinfectant for neonates above 2 months old.[2]

A possible contributing factor associated with reduced blood contamination using 2% chlorhexidine in 70% alcohol is the contact time to dry which needs 30 seconds of skin contact time in comparison to povidone-iodine which needs 90-120 seconds of skin contact time.[2] Adequate skin contact time allows antiseptics to exert their maximal effect on the skin. Therefore, we recommend emphasizing contact time to dry during blood culture sampling training as poor compliance is at risk, especially in paediatrics wards where there may be difficulty handling paediatrics patients and in a rapid turnover of patient wards such as a medical and emergency department.[29]

The site of blood collection is associated with one of the risk factors for blood culture contamination. Collecting blood culture specimens from arterial puncture, lower extremities venepuncture and specimens collected from indwelling catheters have been associated with a greater risk of blood contamination rate.[2,30] While the practice of blood taking from an intravenous catheter might be more convenient to patients, especially in the paediatrics population, blood culture drawn from a newly inserted intravenous catheter has a higher rate of blood contamination compared to blood culture obtained from a dedicated venepuncture[31-32] Therefore, a blood culture should be drawn from a dedicated venepuncture to reduce the blood contamination rate.

Education also plays an important role in reducing blood culture contamination. The educational process should involve increasing awareness among the healthcare workers on blood culture contamination, investigating the blood culture collection practices in the centre, and developing standardization techniques for blood culture collection.[28] Implementing standard operating procedures was able to convert the blood culture collection process from a clean non-sterile procedure to a sterile technique, which was proven to reduce the blood culture contamination rate significantly.[33]

Strength and limitation

To our knowledge, this is the first study analysing Malaysia's national blood culture contamination rate. The inclusion of 27 out of the 51 government hospitals with in-house medical

microbiologists in Malaysia is the strength of this study. However, in view of the retrospective nature of this study, data such as techniques of collecting blood cultures, disinfectants used and site of blood collection were not collected. We would recommend future studies to be conducted on a larger scale looking into epidemiology and factors associated with blood contamination. This information will be a guide for the development of a policy in Malaysia.

CONCLUSION

Blood culture contamination remained a crucial issue in Malaysia and imposes a great challenge in diagnosing bloodstream infections. It is more provident in the adult population and CONs is the most frequently isolated microorganisms in the contaminated cultures. Each respective hospital should enforce major changes to reduce and achieve a lower blood contamination rate.

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