



GLOBAL JOURNAL OF MEDICAL RESEARCH: C
MICROBIOLOGY AND PATHOLOGY
Volume 21 Issue 2 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Comparison of the Contamination Rate and Risk Factor Profile of Blood Culture Done in Emergency Department and MHDU/MICUs

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GJMR-C Classification: NLMC Code: WB 105, WX 215



Strictly as per the compliance and regulations of:



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Results: Blood culture growths were higher in ED (19%). Most common growth was CoNS (4%). The overall contamination rate in this study was (4.8%) The contamination rate was lower in ED (4.4%) when compared to MICU/MHDU (5.4%). The Most common contaminant CoNS. The site with the least contamination rate was the dorsum of the hand (1.28%) in ED and the most common site with contamination was femoral (22%) in ED.

Conclusion: Emergency departments are systems particularly susceptible to a high burden of contaminated blood cultures due to high staff turnover, the need to collect cultures in critically ill patients prior to resuscitation, and the time pressure of obtaining cultures before the first dose of antibiotics. Adherence to clinical decision rules and education of EMT/Registrar is needed to improve the efficiency of blood culture taking practices.

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I. INTRODUCTION

As a way of identifying the organisms in the bloodstream, blood culture is a valuable method for health care practitioners. Blood cultures are an important investigation to help effective management for patients with severe infection/sepsis. A positive blood culture may indicate a conclusive diagnosis, allowing the individual organism to be targeted for therapy. However, false-positive results because of contamination can limit the utility of this important tool¹. Owing to contamination, which happens when species that are not naturally present in a blood sample are grown in culture, false positives arise. For decades, contaminated cultures have been described as a

problematic problem and continue to be a source of irritation for both clinical and laboratory workers. Clinicians must assess if the organism represents a clinically relevant infection associated with a high risk of morbidity and mortality or a false-positive result without any clinical effects in the face of a positive blood culture outcome. Contaminated samples increase the workload of the laboratory and can interrupt patient management or cause incorrect changes. This can prolong hospitalization of patients, increase the risk of harm, and increase health boards' costs. Current guidelines advocate a contamination rate of 2– 3% is acceptable². Emergency departments (EDs) are important locations for the diagnosis and management of bacteraemia³. Blood cultures are considered the “gold standard” for the diagnosis of bacteraemia. Emergency departments are networks that are especially vulnerable to a heavy burden of infected blood cultures due to the high turnover of workers, the need to collect cultures before resuscitation of critically ill patients, and the time pressure to acquire cultures before the first dose of antibiotics⁴. This study is to compare the contamination rate and risk factors of blood culture done in the emergency department and MICU/MHDU.

II. MATERIALS AND METHODS

Study design: This was a prospective observational study comparing the blood culture contamination rate and risk factors in ED and MICU/MHDU.

Study setting: Christian medical college hospital, established in 1900, is a tertiary care teaching hospital situated in Vellore, Tamil Nadu. It is an important referral center in Tamil Nadu and neighboring states. The ED is one of the largest in the country and has about 74,000 admissions per year. It has a central triage system that triages all patients presenting to the ED. There are 2700 beds in the hospital of which 115 beds are allotted for ICU care. Medical Intensive care unit (MICU) and the Medical High Dependency Unit (MHDU) have 12 beds each. They receive patients directly from the ED and from Medical Wards through an open admitting system. **Participants:** All patients with features of bacteraemia/fever or any infectious condition who underwent blood culture investigation in the emergency department and

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in the MICU/MHDU were recruited. Data with respect to culture methodology was collected from the ED department and MICU/MHDU.

Inclusion criteria: • Patients requiring blood culture taken in the ED. • Patients requiring blood culture in MHDU/MICU. • Patients above the age of 18. • Patients consenting to participate in the study.

Exclusion criteria: • Patients below the age of 18. • Patients NOT consenting to participate in the study. • Cultures transferred to the lab after 12 hours.

Duration of study: The study was conducted for a period of 2 months from January 2019 to February 2019. Sample size and sample size calculation: A total of 998 (570 from ED and 428 from MICU/MHDU) were recruited in the study.

Statistical analysis: Data from the Clinical Research Form was entered into epidata worksheet and the results were analysed using MS-Excel, epidata and medical.

III. RESULT

Table 1: Demographic characteristics

	ED (n=401)	MICU/MHDU (n=379)	Total (780)	P value	CI (95%)
Mean age (SD)	51.3 (17.5)	46.4 (16.5)	46.2 (17.2)	0.001	2.765-7.054
Male (%)	340 (59.6)	269 (62.9)	478 (61)		
Female (%)	230 (40.4)	159 (37.1)	389 (39)		

The mean age of population in the ED culture arm was 51 years and in the MICU/MHDU was 46 years. There is male predominance in both the arms. The total males accounted to 61% and the females accounted to 39%.

Table 2: Demographic variables

	ED (n=570)	MICU/MHDU (n=428)	Total (n= 998)
Comorbidities			
Diabetes	209(36.7)	130(30.4)	339(34)
Hypertension	186(32.6)	133(31.1)	319(32)
Cancer	55(9.6)	9(2.1)	64(6.4)
CKD	34(6.0)	63(14.7)	97(9.7)
CLD	24 (4.2)	8(1.9)	32(3.2)
HIV	9(1.6)	2(0.5)	11(1.1)
Admission diagnosis			
AUFI	133(23.3)	19(4.4)	152(15.2)
Lung infection/Pathology	100 (17.5)	93(21.7)	193(19.3)
Soft tissue infection	81(14.2)	1 (0.2)	82 (8.2)
Urogenital infection	64(11.2)	11 (2.6)	75(7.5)
Hepatobiliary pathology	37(6.5)	35(8.2)	72 (7.2)
Haematological conditions	23(4.0)	60(14.)	83(8.3)
Oncopathology	24(4.2)	8 (1.9)	32 (3.2)
Sepsis and septic shock	17 (3.0)	60 (14.0)	77(7.7)
Others	91(15.9)	141(32.94)	182(182)

a) Comorbidities

The most common comorbidity in this study was diabetes comprising 36% in ED and 30% in MICU/MHDU. The second most common comorbidity was hypertension comprising 32% in ED and 31% in MICU/MHDU. The number of patients with CKD were more in MICU/MHDU accounting 14%. A total of 11 HIV cases were included in this study of which 9(1.6) in ED and 2 in MICU/MHDU.

b) Admission Diagnosis

Lung infection/Lung pathology is the most common admission diagnosis encountered in the study

comprising of 193 cases (19.3%). However, in ED the most common admission diagnosis was AUFI comprising of 23% of total ED cases. There are no cardiac diseases in ED. Others includes neuroleptic malignant syndrome, Diphtheria infection, G6PD deficiency, post renal transplant, nephrotic syndrome, polymyositis, Liver Abscess, cardiac pathology, acute abdomen, toxicology, autoimmune diseases.

Table 3: Blood parameters at the time of admission

Variable (Mean/ SD)	ED (n=428)	MICU/MHCU (n=570)	P Value	CI(95%)
Haemoglobin	11.82(7.29)	9.89 (2.74)	0.001	1.20-2.65
Total Leucocyte count	14755 (21608)	13720 (12911)	0.380	-1279- 3348
Serum Albumin	3.460(0.90)	2.76(0.87)	0.001	0.57-0.81

The mean value of total leucocyte counts in ED arm is higher than that of MICU/MHCU. The mean serum albumin levels were lower in MICU/MHCU arm than ED arm. Hypoalbuminemia is observed in patients with positive culture growth in MICU/MHCU. The mean Hb levels were also lower in MICU/MHCU than ED arm.

Table 4: Site of poke

Site of Poke	ED (n=570)	MICU/MHCU (n=998)
Brachial	465(81)	129(30.1)
Femoral	18(3.2)	1(0.2)
Dorsum of hand	78(13.7)	1(0.2)
Central line	7(1.2)	153(35.7)
Arterial line	0	144(33.6)
EJV	2(0.4)	0

The most common site of poke for culture in ED is brachial 81% followed by dorsum of hand 14%. There was no arterial line in ED. The most common site of poke for culture in MICU/MHCU is Central line (35%) followed by Arterial line (33%). There was no EJV line in MICU/MHCU.

Table 5: Distribution of cases based on culture growth

Culture Growth	ED(n=570)	MICU/MHCU (n= 428)	Total (998)
No growth	462(81.1)	345(80.6)	807(80.9)
Growth	108 (18.9)	83 (19.4)	191(19.1)
True Pathogen	83(14.6)	60(14)	143(14.3)
No of Contaminants	25	23	48
Contamination rate	4.4	5.4	4.8

Out of 998 cases, 807(81%) showed no growth of which 462 cases are in ED and 345 cases were in MICU/MHCU. A total of 48 cases (4.8) were contaminated in the study out of which 25 cases were in ED and 23 in MICU/MHCU. The rate of contamination is lower in ED (4.4%) when compared to MICU/MHCU (5.4%). The total rate of contamination is 4.8%. Out of 998 cases, 191(19%) showed culture growth of which 108 cases are in ED and 83 were in MICU.

Table 6: Culture growth

Culture growth	ED (n=570)	MICU/MHCU (n=428)	Total (n=998)
No growth	462(81.1)	345(80.6)	807(80.9)
E.coli	20(3.5)	8(1.90)	28(2.80)
Staph aureus	9(1.60)	4(0.90)	13(1.30)
Gram negative bacilli	2(0.40)	1(0.20)	3(0.30)
Pseudomonas	4(0.70)	3(0.70)	7(0.70)
Stept. Pneumoniae	6(1.10)	2(0.50)	8(0.80)
Proteus	1(0.20)	-	1(0.10)
Candida	1(0.20)	1(0.20)	2(0.20)
Salmonella typhi	1(0.20)	-	1(0.10)
Enterobacter species	2(0.40)	-	2(0.20)

Vibrio	1(0.20)	-	1(0.10)
Klebsiella	2(0.40)	12(2.80)	14(1.40)
Burkholderia	1(0.20)	1(0.20)	2(0.20)
Stenotrophomonas	1(0.25)	-	1(0.10)
Acinobacter boumani	1(0.20)	1(0.20)	2(0.20)
Polyinfection	1(0.20)	5(1.20)	6(0.60)
NF- GNB	4(0.70)	14(3.3)	18(1.80)
Yeast	-	1(0.20)	1(0.10)
Coagulase negative Staph.	23(4.0)	7(1.6)	30(3.0)
Viridians Streptococci	2(0.40)	-	2(0.20)
Moraxella	1(0.20)	-	1(0.10)
Contaminants	25(4.4%)	23(5.40)	48(4.80)

In ED, the most common positive pathogen grown on culture was E.COLI (3.5) followed by Staph Aureus 9(1.6%) and the most common pathogen grown in MICU/MHDU arm was Nonfermenting gram negative bacilli (3.3%) followed by Klebsiella (2.8). The total numbers of contaminants were 48 out of which 25 in ED

and 23 in MICU/MHDU. Ø During study most common contaminant was CoNS total of 26 cases out of which more were in MICU/MHDU (16 cases). Ø Second most common contaminant was NF-GNB 1 in each department.

Table 7: Distribution of Contaminant in ED and MICU/MHDU

	ED N=25	MICU N=23	TOTAL N=48
CoNS(As Contaminants)	10(40)	16(69.5)	26(54.20)
NF-GNB(As Contaminants)	1(4)	1(4.3)	2(4.20)
True Contaminant	14(56)	6(26.2)	20(41.60)

Total contamination was 48. Most common contaminant was CoNS (10 cases). NF-GNB as contaminant were found 1 in each department. Total

True contaminants were reported (20 cases) out of which 14 were in ED and 6 were in MICU/MHDU.

Table 8: Contamination IN ED and MICU/MHDU

Department	Contaminants		P Value	Odds Ratio	95% CI
	YES (N=48)	NO (N=950)			
ED	25(52.1%)	545(57.4%)	0.470	0.808	0.452- 1.444
MICU/MHDU	23(47.9%)	405(42.6%)			

A total of 48 cases were contaminated in the study. IN ED 25 cases were have contamination. In MICU/MHDU 23 cases were having contamination. In

our study there was no significant difference found in contamination rate between culture done in ED and MICU/MHDU.

Table 9: Contamination based on site of poke

Site of Poke	ED	MICU/MHDU
Brachial	19/465(4.08%)	8/129(6.20%)
Femoral	4/18(22.2%)	0
Dorsum of hand	1/78(1.28%)	0
Central line	1/7(14.28%)	9/153(5.88%)
Arterial line	0	6/144(4.16%)

The most common site of poke for contamination in ED was from the femoral (22.2%) and the least common site of contamination was dorsum of hand (1.28%). In MICU/MHDU, the most common site of contamination is from the Brachial (6.20%) and the least common is from the arterial line (4.16%). Arterial line blood culture sample was not done in Ed. No femoral

and Dorsum of hand blood culture sample was taken in MICU/MHDU.

Table 10: Procedure related characteristics

Variables	ED (n=100)	MICU/MHDU (n= 100)
Sterile gloves	100	100
Mask	14	75
Wear in sterile manner	91	100
Crowding present	35	0
Allow to dry	32	100
Febrile	42	19
Scrub hand	0	62
Plastic apron	0	66
Head cap used	2	63
Culture bottle top cleaned	5	0
First Attempts	91	92
Adequate barrier method	14	64
Antibiotic taken prior	9	47
Chlorhexidine	115(20.2)	426(99.5)
Betadine	455(79.8)	2(0.5)
Blood culture set	443(77.7)	218(50.9)
Dressing set	115(20.2)	1(0.2)
Others	12(2.1)	209(48.8)
Volume collected		
5cc	197(34.6)	6(1.4)
10cc	364(63.9)	420(98.1)
<5cc	9(1.6)	2(0.5)
Culture taken by		
EMT	543(95.3)	0
Registrar	10(1.8)	382(89.3)
Intern	17(3.0)	46(10.3)

In our observation study it was found that there was no scrubbing of hand before the procedure in ED whereas scrub hand was found in 62% cases in MICU/MHDU. The gloves were worn in unsterile manner in 9 out of 100 cases of ED and overcrowding during venipuncture was found in 35 cases. The antiseptic used in ED was chlorhexidine (20% cases) and betadine (80%). The antiseptic used in MICU/MHDU was chlorhexidine in all the cases (100%). In ED, the antiseptic was allowed to dry in 32 cases only. The set used for blood culture was blood culture set (77%) and dressing set (20%) in ED. The blood culture set was

used in 51% cases of MICU/MHDU and other sets in 49% cases. In ED, the volume collected was 5cc in 35% cases and 10 cc were collected in 64 % of cases. In MICU/MHDU, 10cc volume was collected in 98% of cases and in 2% cases < 5 cc was collected. In ED 95% of cases, were collected by EMT, 17 by interns and 10 by registrars. Where as in MICU/MHDU most of the cultures were taken by registrars (89%). In MICU/MHDU, 382 by registrar and 46 by interns. The blood culture was done in first attempt in 91% of cases of ED and 92% cases of MICU/MHDU.

Table 11(A): Procedure variables in ED

Procedure variable		ED contaminants (n=100)		P value	Odds ratio	95% CI
		Yes (n=5)	No (n=95)			
Mask	No	5	81	1.000	--	--
		100%	85.3%			
	Yes	0	14			
			14.7%			
Sterile manner	No	0	9	1.000	--	--
			9.5%			
	Yes	5	86			

		100%	90.5%			
Wear cap	No	5	893	1.000	--	--
		100%	97.9%			
	Yes	0	2			
			2.1%			
Adequate barrier methods	No	4	82	0.537	1.577	0.163-15.234
		80.0%	86.3%			
	Yes	1	13			
		20.0%	13.7%			
Allow to dry	No	2	66	0.324	0.293	0.046-1.848
		40%	69.5%			
	Yes	3	29			
		60%	30.5%			
Overcrowding	Yes	1	34	0.655	0.449	0.048-4.176
		20%	35.8%			
	No	4	61			
		80%	64.2%			

Table 11(B): Procedure variables in ED

Procedure variable		ED contaminants (n=570)		P value	Odds ratio	95% CI
		Yes (n=25)	No (n=545)			
Set Used	Others	5	122	0.779	0.867	0.319-2.357
		20%	22.4%			
	Blood culture set	20	423			
		80%	77.6%			
volume	<=5cc	7	199	0.386	0.676	0.278-1.647
		28%	36.5%			
	>5cc	18	346			
		72%	63.5%			

The blood culture procedure variables done in ED were not significant with contamination (p value >0.05).

Table 12(A): Procedure variables in relation to contamination in MICU/MHDU

Procedure variable		MICU/MHDU (n=100)		P value	Odds ratio	95% CI
		Yes (n=5)	No (n=95)			
Mask	No	1	24	1.000	1.714	0.191-15.481
		16.7%	25.5%			
	Yes	5	70			
		83.3%	74.5%			
Scrub hand	No	3	35	0.671	0.593	0.113-3.101
		50%	37.2%			
	Yes	3	59			
		50%	62.8%			
Apron use	No	1	33	0.661	2.705	0.303-24.131
		16.7%	35.1%			
	Yes	5	61			
		83.3%	64.9%			
Wear cap	No	2	35	1.000	1.186	0.207-6.815
		33.3%	37.2%			
	Yes	4	59			
		66.7%	62.8%			
Allow to dry	No	2	34	1.000	1.133	0.197-6.514
		33.3%	36.2%			
	Yes	4	60			
		66.7%	63.8%			

Table 12(B): Procedure variables in relation to contamination in MICU/MHDU

Procedure variable		MICU/MHDU (n=428)		P value	Odds ratio	95% CI
		Yes (n=23)	No (n=405)			
Set Used	Others	18	192	0.756	1.125	0.535-2.367
		58.1%	55.2%			
	Blood culture set	13	156			
		41.9%	44.8%			
volume	<=5cc	1	7	0.367	2.584	0.304-21.94
		4.3%	1.7%			
	>5cc	22	398			
		95.7%	98.3%			

The blood culture procedure variables were not significant with contamination (p value >0.05).

IV. DISCUSSION

This was a prospective study comparing the contamination rate and risk factor profile of blood culture done in the Emergency Department and MHDU/MICUs. The analysis contained a total of 998 cases. Out of which 570 were from ED and 428 were from MICU/MHDU. This first Indian studies looking at the rates of BCC in ED and MICU/MHDU to the best of our knowledge.

The mean age in our study in ED is 51.3 years and MICU/MDHU is 46.4 years. A similar study by Choi et al had shown a mean age of 67 years in ED and 65years in general ward⁵. As life expectancy in India is less when compared to Singapore, the mean age in our study is less than the study done by Choi et al at Singapore⁵.

Our study shows a slight male predominance which is in contrast to Choi et al study where there is female predominance⁵. This might be because of the high female sex ratio (1:1.04) in Singapore when compared to India⁶.

The most common comorbidity in our study is diabetes accounting for 339(34%) of cases. Choi et al also showed diabetes as the most common comorbidity accounting for 163/400(40.8%) cases⁵. There is a positive association of diabetes with culture growth in our study and study by Lee et al.⁷. The mean hemoglobin in this study in ED was 11.82mg/dl which is almost equivalent to the mean hemoglobin in Choi et al study which was 12.2 mg/dl⁵. The mean total leucocyte counts in ED were higher (14.7 x10⁹/L) when compared to Choi et al study (11.6x10⁹/L) as most of our cases presented with high fever⁵.

The mean serum albumin in our study is 3.4 gm/dl which is slightly lower than Choi et al study which was 3.6gm/dl⁵. The total rate of contamination in our study done in ED and MICU/MHDU was 4.8%. In this study, the rate of contamination is lower in ED (4.4%) when compared to MICU/MHDU (5.4%).

A Similar study done by Choi et al showed blood culture contamination rates were higher in ED comprising 4% when compared to general wards (0.5%)⁵. In a study by Ramirez et al showed a blood

culture contamination rate in ICU decreased from 23% to 13 % by using an education-based intervention⁸.

Raja et al studied 11000 patients over 2 years period showed that the contamination rates were higher in ICU (31%) when compared to ED (20%)⁹. The Bentley et al study also found that BCC rates were higher in ED (4.74 percent), which they were able to reduce to 2 percent within a year with a simple and clear checklist and rationalizing equipment to help and not detract from this approach with a specifically specified preferred technique². Self WH et al in their study was able to reduce the BCC rates from 4.3% to 1.7% by following a standardized, sterile process for culture collection using chlorhexidine skin antisepsis, sterile gloves, sterile drapes, and checklists¹⁰.

In our study, the growth is seen in 191/998 (19.1%) cases. Of which growth in ED is 108 (18.9%) and in MICU/MHDU is 83(19.4%). A higher percentage of growth in ED may be because of more number of patients in this arm. A study done by Choi et al also had near similar growth in ED (17.5 %)⁵. A similar study done in ICU by Ramirez et al showed a culture growth of 31%(12). The most common contaminant found during this study was CoNS which was similar to most of the studies^{7,9}.

The blood culture procedure variables were not significant with contamination (p-value >0.05). But according to the study by Lee et al in Taiwan, there was a strong correlation between blood culture contamination rates and the degrees of ED crowding (P.001)^{7,11}.

A study done by Kim et al on blood culture contamination stated that the contamination rate was 0.5% in routine sterile gloving and 0.9% in optional sterile gloving with a significant P-value. Wearing a sterile glove in an aseptic manner before venepuncture may reduce blood culture contamination¹². Various studies on the BCC rate among different antiseptics showed no significant difference among the antiseptics used¹³. Weinstein et al. study suggests that iodine tincture and chlorhexidine tincture are equivalent antiseptic agents for skin antisepsis in patients who require blood cultures¹⁴.

In our study CoNS are commonly isolated contaminants (26 cases) from blood cultures, however,

they can also cause true bloodstream infections. Due to its clinical effects, this distinction is of practical significance because it can avoid the unfair use of antibiotics and the development of antimicrobial resistance. More importantly, the inability to ascertain and treat true bacteremia can prove costly to the patient, more so if the patient is critically ill or immunocompromised. A clue to the significance of CoNS-positive blood cultures is the number of positive cultures, thus more the number of positive cultures, the higher the chances of it being true bacteremia. However, this is not feasible if before beginning the patient on antimicrobial agents, only a single culture sample is collected. Quantitative blood cultures (QBCs) can aid interpretation. QBCs are cumbersome and not very feasible. On the other hand, the time-to-positivity (TTP) of blood cultures after loading in the automated systems like BacT/ Alert may be a useful surrogate test for bacterial density and interpretation of the significance of CoNS isolated from positive blood cultures¹⁵.

V. CONCLUSION

Blood culture contamination is a common clinical problem and often leads to both adverse impacts on health care and costs. We identified a low contamination rate among blood cultures collected in the adult ED at our hospital 4.4% when compared to MICU/MHDU (5.4%). We researched the process of blood culture collection and found inconsistent methods for culture collection with recurrent breaches in aseptic technique in ED. As we know ED frequently experiences high patient volumes and crowding and that leads to making things do as soon as possible and in that way, many lapses in protocol happen and that leads to degraded performance of blood cultures, both increasing the rate of contamination and decreasing the diagnostic yield.

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