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Assessment of blood culture contamination rate in a tertiary care hospital: A single centre study of south India.

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Background *: Blood culture is the gold standard for the diagnosis of bacteremia. Contaminated blood cultures have been recognized as a troublesome issue. Emergency departments and intensive care units (ICU) are particularly susceptible to contaminated blood cultures.*
Methods *: It was a retrospective study carried out on blood cultures submitted to department of microbiology from in patients in intensive care units (ICU's) at SVIMS, tirupathi during three year period from January 2017 to December 2019.*
Results *: A total number of blood cultures during this period were 46325, in which conventional were 27211, and automated bactalert were 19114. Among these, 4298 and 5456 were positive blood culture samples in conventional and automated blood cultures respectively. Contaminated blood cultures were 598 by conventional and 728 by automated bacTAlert 3D system methods. The mean blood contamination rate was 2.8, 3.2, 2.4 for 2017,2018,2019 respectively. Coagulase negative staphylococcus was the most predominant isolate, followed by Aerobic spore bearers (ASB) and diptheroids. Staphylococcus hominis was the most common isolated species of CONS. The greater number of samples were from Emergency medicine department followed by Nephrology department.*
Conclusion*: Strict implementation of disinfectants, educational interventions, sampling from separate venipuncture sites under aseptic precautions, hand hygiene , proper infection control practices before and after collecting the sample are important in decreasing blood culture contamination rate.*

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I. Introduction:

The blood culture (BC) represents a critical tool for the health care professional as a means of detecting the organisms in the blood stream. A positive blood culture can suggest a definitive diagnosis(1). Blood stream infections are the major cause of mortality and morbidity in hospitalized patients. Source of bacteremia can be either primary or secondary. (2). The prevalence of sepsis due to blood stream infections in intensive care units (ICUs) remains high (3-5).False-positive results can limit the utility of this important tool. In blood cultures, false positivity is usually due to contamination. Contaminated blood cultures have been recognized as a troublesome issue for decades. Contaminated blood cultures can be problematic when interpretating the blood cultures positivity. Clinicians must determine whether the organism represents a clinically significant infection or a false positive result. The issue in recent years is the increasing use of central venous catheters and other indwelling vascular access devices. Interpretation of culture results for patients with these devices is particularly challenging.(6,7)

The most common blood culture contaminants are coagulase-negative *staphylococci*(CONS),and more frequent pathogens now-a-days. These bacteria have gained clinical importance as the etiologic agents of catheter-associated bacteremia and bacteremia in patients with vascular and other prosthesis.(8-13)

The number of blood culture sets has proved to be a useful aid in interpretation of the clinical significance of positive blood cultures.

Numerous advances in blood culture systems in recent decades, have noted that an increasing proportion of blood culture isolates represent contamination compared with those in past years . Several broth medium formulations such as the BACTEC plus resin media, and BacT/ALERT FN media have been shown to have improved detection of CONS which are often contaminants mostly.(14-20)

Many interventions have been shown to reduce blood culture contamination rates. These include collection from separate venipuncture sites, use of specific antiseptic preparations. The uncertain clinical significance of

potential contaminants leads to longer hospital stay, unnecessary antibiotic therapy, and additional laboratory testing.(21-24)

II. Material And Methods :

This is a hospital based retrospective study which was carried out on blood cultures submitted to department of microbiology from in patients in intensive care units (ICU's) at SVIMS, tirupathi during three year period from January 2017 to December 2019.

For all the blood culture bottles received , we retrieved all the demographic data and blood culture bottles were processed as per standard protocol(25). In the case of a positive blood culture, an immediate Gram stain was performed in automated blood culture system, and subcultures were done on Macconkey, nutrient and blood agar, whereas in conventional methods, subcultures were done at regular intervals. All microorganisms known to be true pathogens were excluded, and only the contaminants were included in our study.

The rate of blood culture contamination was calculated by dividing the total number of contaminated blood cultures by the total number of blood cultures collected during study period.

Records of all the blood cultures were reviewed and the data was analysed for age, gender of the patient, department, total number of cultures , type of growth and type of culture system used.

All the data was recorded in Microsoft excel sheet and were analysed using SPSS 20 software.

The study was reviewed and approved by institutional ethics committee. (IEC).

III. Results

Of all the blood culture samples received (46325) in the microbiology laboratory during the study period, the conventional blood cultures were 27211, and bactalert were 19114. Out of these 4298(15.75%) and 5456(28.5%) were positive blood culture samples in conventional and automated blood cultures respectively.

We found that 592(2.1%) samples and 728(3.8%) samples appeared contaminated in conventional and automated blood cultures respectively.

Coagulase negative *staphylococcus* was the most predominant isolate, with 817(61.9%) blood culture bottles, 320(54.5%) being conventional blood cultures and 497(68.26%) being automated blood cultures, followed by *Aerobic spore bearers*(ASB) [n= 342(25.9%)] and *Diptheroids* [n=161(12.1%)]. *Staphylococcus hominis* was the most common isolated species of coagulase negative *Staphylococcus* in 434 blood culture bottles(53.1%).

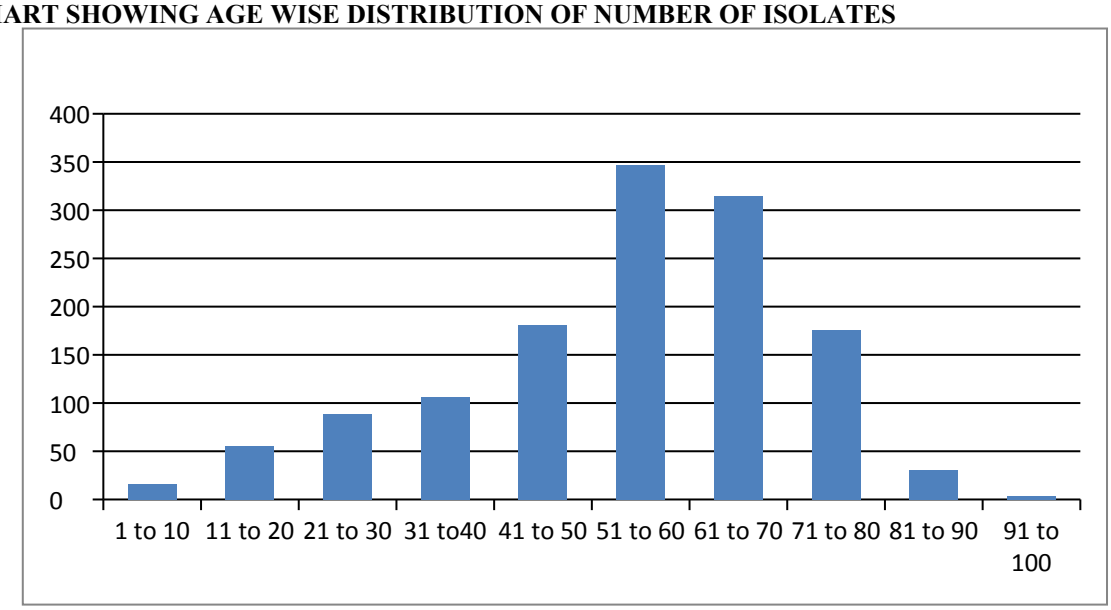
Gender wise distribution being males [n=802(61%)] and females [n=518(39%)]. The mean age for blood culture and bactalert was 65.7 and 72.8 respectively . more number of samples were from 51-60 years of age (26.3%) , followed by 61-70 years of age (23.9%).

The majority of samples were from emergency medicine department (45%) followed by nephrology department(25%).

AGE WISE DISTRIBUTION

age	number
1 to 10	16
11 to 20	55
21 to 30	89
31 to40	106
41 to 50	181
51 to 60	347
61 to 70	315
71 to 80	176
81 to 90	31
91 to 100	4

CHART SHOWING AGE WISE DISTRIBUTION OF NUMBER OF ISOLATES



Sex wise distribution

Male	802
Female	518

CHART SHOWING SEX WISE DISTRIBUTION

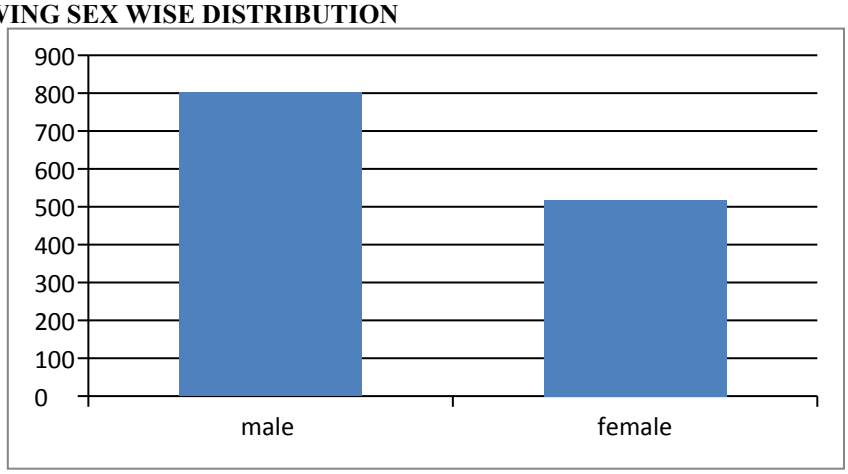


TABLE SHOWING DEPARTMENT WISE DISTRIBUTION OF CONTAMINANTS

department	
card	25
ctsurg	59
emd	597
endo	10
gen surg	2
med	66
med onc	8
nephrology	335

CHART SHOWING DEPARTMENT WISE DISTRIBUTION

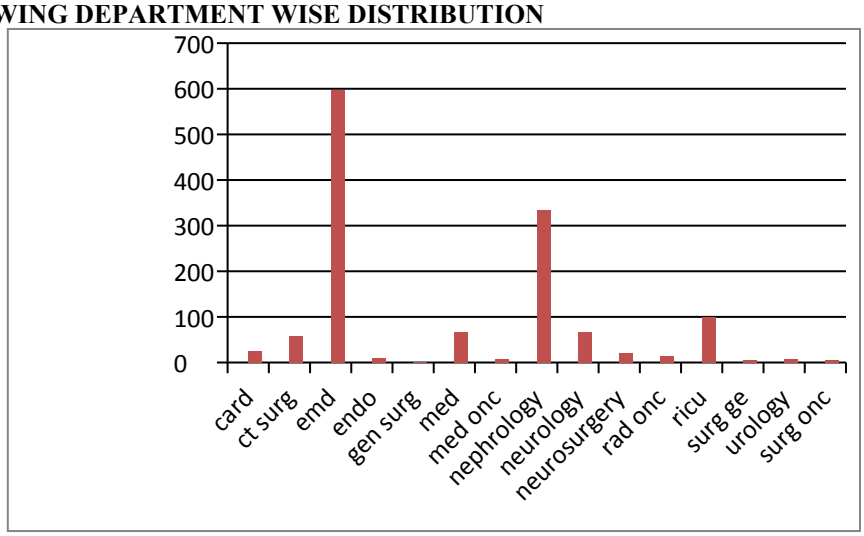


TABLE SHOWING DISTRIBUTION OF CONTAMINANTS AMONG CONVENTIONAL BLOOD CULTURES

	BLOOD CULTURE			
	ASB	DIPTHEROIDS		CONS
2017	44	27		93
2018	59	8		176
2019	87	47		51

TABLE SHOWING DISTRIBUTION OF CONTAMINANTS AMONG BACTALERT

	BACTALERT			
	ASB	DIPTHEROIDS		CONS
2017	40	18		235
2018	52	11		203
2019	60	50		59

TABLE SHOWING BLOOD CULTURE CONTAMINATION RATE DURING STUDY PERIOD

	Blood culture Total	Bactalert Total	Blood culture Contamination(rate)	Bactalert Contamination(rate)	Total blood culture Contamination rate
2017	**9870**	**6246**	**164(1.6)**	**293(4.6)**	**2.8**
2018	**9059**	**6605**	**243(2.6)**	**266(4.0)**	**3.2**
2019	**8282**	**6263**	**185(2.2)**	**169(2.6)**	**2.4**

CHART SHOWING CONTAMINATION RATE AMONG CONVENTIONAL BLOOD CULTURES

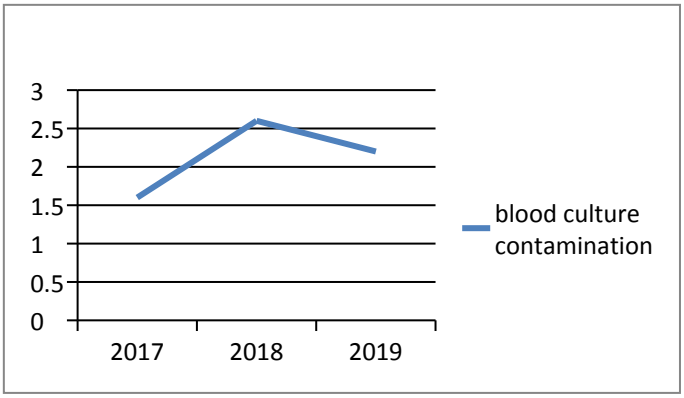


CHART SHOWING CONTAMINATION RATE AMONG BACTALERT

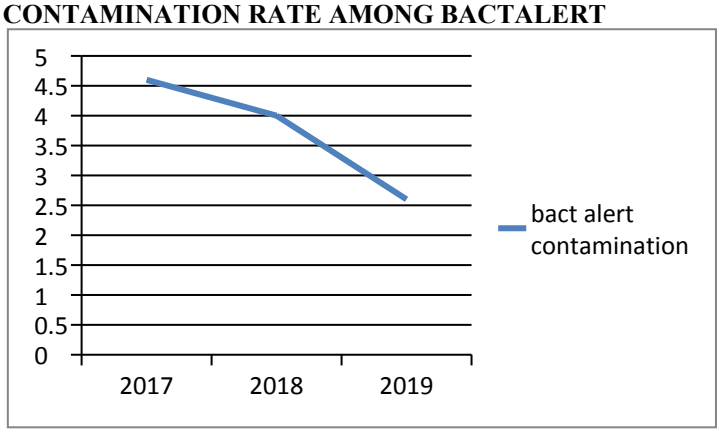
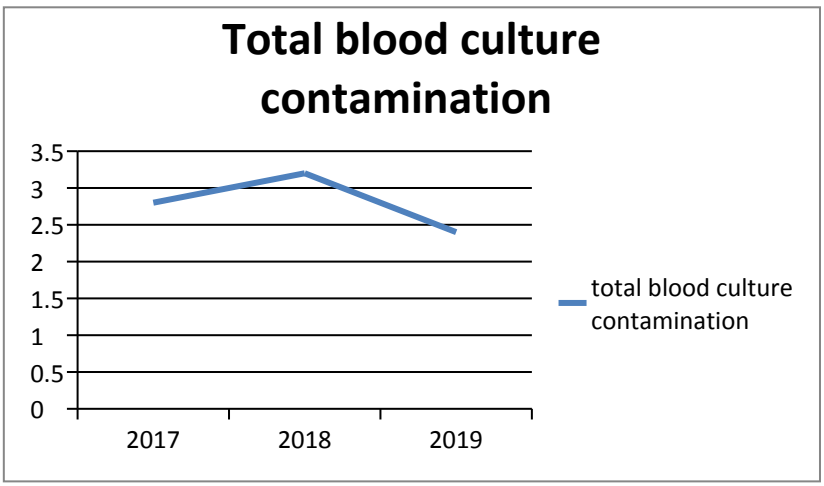


CHART SHOWING TOTAL BLOOD CULTURE CONTAMINATION RATE DURING STUDY PERIOD



IV. Discussion

Blood stream infections are significant cause of mortality and morbidity. World wide mortality rate due to blood stream infections is between 30% and 55% (26-29). Specimen collection from intravenous catheter is associated with higher blood culture contamination rates (30).cons and other skin normal commensals are isolated very frequently. Contamination rates are different based on the institutions and are related to blood collecting methods, and skin antiseptic methods .(31,32,33)

Blood culture remains the gold standard test for BSI. The contaminated blood cultures leads to false positive results. In recent years, it has been documented that blood culture contaminants are frequent and incurring additional expenditure to the patient.(34,35) In various studies, CONS, *Micrococcus*, Alpha *haemolytic viridians group Streptococci, Corynebacterium* and *Bacillus sps.* have been reported as culture contaminants (36).

In our study, we found that 592 samples and 728 samples were contaminated in conventional and automated blood cultures respectively. We observed CONS was the most predominant isolate, which in similarity with other studies (37,38), followed by ASB, diptheroids. Kim et al also reported CONS is most predominant isolate.(39).Calfee et al and novis et al. also reported CONS as predominant contaminant(40,41). Studies from some institutions reported CONS as frequent isolate as contaminant (42-45). *Staph.hominis* was the most common isolated sps of CONS(53.1%). Min et al reported *S.epidermidis* as the most frequently isolated contaminant which is in contrast with our study (46). A recent study from Riyadh, Saudi arabia also identified *S.epidermidis* as the most frequently isolated contaminant.(47)

In our study, contamination rate was higher in males, than the females. More number of samples were from 50-70 yrs of age, which is in line with other studies (48).Majority of samples were from EMD(45%) which is in concordance with other studies (49,46) and this may be due to speedy collection of blood samples, improper aseptic procedures, inadequate staff. Choi et al. showed higher contamination rates in EMD (50). Lee et al showed a strong correlation between BCC rates and crowding in EMD (51). Ramirez et al reported higher BCC rate in ICU rather than in EMD.(52). self et al. showed increased blood culture contamination rates in EMD.(53). Blood culture contamination is higher in EMD than other ICUs, due to differences in techniques used for the collection of blood sample, overcrowding, and rapid collection of samples (54,55). Bowen et al reported contamination rates as high as 10-12% in EMD. (56)

The blood culture contamination rate should be 2-3% , as per international standards (31,32,38,39,57,58). The blood culture contamination rate, in our study, for the years 2017, 2018, 2019 were 2.8, 3.2, 2.4 respectively, which is maintained as per international standards. The contamination rate was decreased in 2019 after implementation of proper collection procedures, under proper aseptic conditions, proper education and training of the nursing staff, internees. A study from Malaysian hospital reported a reduction in contamination rates from 6 to 4 post after implementing standard infection control practices(59). Weinsten et al, reported blood contamination rate of 2.3 which is in similar to our study(60). After proper implementation of infection ,prevention and control practices, proper education ,avoidance of drawing blood samples from intravenous lines reduced the rate from 3.2 in 2018 to 2.4 in 2019. Snyder et al found that the contamination rate was higher in samples collected from IV lines.(61).

A study from Nigeria, has recorded a contamination rate of 10.4% which was higher than our study (37). Studies showed that blood culture contamination rates are usually higher at teaching hospitals (38,63). Archibald et al. a study from tertiary care teaching hospital reported a rate of 7.8% (62) . malik et al. reported a contamination rate of 18% which is far higher than benchmark standards(64).

Decrease in blood culture contamination rates should significantly lower the duration of hospital stays, and usage of unnecessary antibiotics. BCC rates should be regularly monitored as a part of hospital infection, prevention and control programme in all the hospitals and teaching institutions. This would help in decreasing contamination rates, decrease in number of emerging drug resistant strains. We implemented the use of disinfectants, increasing the contact time approximately 20-30 seconds of disinfectant, educational interventions, sampling from separate venipuncture sites, use of double-needle technique, which finally resulted in reduction in BCC rate. Proper infection control practices like hand hygiene before and after collecting the sample, proper disinfection of the collecting site.

Several factors like improper aseptic techniques for skin sterilization while collecting blood sample, collection from existing invasive devices like intravenous catheters contributes to blood culture contamination(49,65). Trained staff have been reported to result in less contamination rates(66). Studies showed that a few minutes of drying time has impact on blood culture contamination .(67). The effect of alcohol while collecting blood culture sample also has reported in decreasing contamination rates (68). Inadequate quantity, simultaneous , multiple drawing of blood for different tests, also has impact on contamination rates.(49)

Limitations :

As this is a restrospective study, lack of clinical data is one of the drawback, so that clinical outcome couldn't be assessed. And inability to calculate the exact number of blood cultures drawn through intravenous

catheter and peripheral venipuncture is another limitation, as contamination rates would be higher, when drawn from intravenous catheter and indwelling devices.

V. Conclusion

Blood culture contamination leads to excessive use of antibiotics, that leads to development of antimicrobial resistance, prolonged hospital stay, added financial consequences. We focused on improving sample collection procedures, proper aseptic precautions, proper training of staff. Posters showing collection of blood samples were posted in all the areas of the hospital to reduce the blood culture contamination.

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