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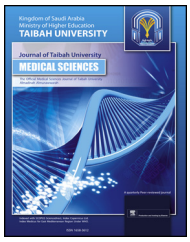

Original Article

# Rate of blood culture contamination in a teaching hospital: A single center study

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**الملخص**

**أهداف البحث:** قد يؤدي تلوث عينات مزرعة الدم إلى مشكلة كبيرة في العناية بالمريض، وذلك من خلال إعطائه مضادات حيوية ليس بالضرورة أن يتناولها وقد تكون لها أعراض جانبية، وإهدار للموارد الصحية. تهدف هذه الدراسة لحساب معدل تلوث عينات مزرعة الدم في مستشفى الملك خالد الجامعي بالرياض، ومعرفة الأسباب المحتملة لذلك.

**طرق البحث:** تعتبر هذه الدراسة ذات تصميم مسحي استعادي، وتمت مراجعة كل عينات مزرعة الدم التي سلمت إلى مختبر وحدة الأحياء الدقيقة في مستشفى الملك خالد الجامعي خلال فترة الدراسة من ١ يناير إلى ٣١ ديسمبر لعام ٢٠١٢ م.

**النتائج:** وجدنا أن متوسط نسبة تلوث عينات مزرعة الدم لعام٢٠١٢م هو ١.٩٪، بينما كان معدل عينات تجرثم الدم الحقيقي هو ٨.٧١٪. كما وجدنا أن النسبة العظمى من العينات الملوثة هي من المكورات العنقودية سالبة الكواجيوليز بنسبة ٨٧٪. وقد لاحظنا أن معدل تلوث عينات مزرعة الدم يرتفع بشكل ملحوظ في موسم الصيف مقارنة بالأشهر المتبقية من السنة (في شهر يونيو ١.٣٨٪، وفي يوليو ٣.٩٧٪، وفي اغسطس ٣.٧٢٪)، أخيرا فإن الوحدات الجراحية كان لها النصيب الأكبر من معدل تلوث عينات مزرعة الدم ٣.٩٢٪، يليها وحدات العناية المركزة ٢.٦١٪، ثم الوحدات الباطنية بمعدل ٢.٤٨٪.

**الاستنتاجات:** إن معدل تلوث عينات مزرعة الدم في مستشفى الملك خالد الجامعي لعام ٢٠١٢ م يعتبر ضمن المعدل العالمي المقبول لتلوث عينات مزرعة الدم، كما أن الوحدات الجراحية كان لها أعلى نسبة لتلوث عينات مزرعة الدم، وأن المعدل يرتفع بشكل ملحوظ في فترة الصيف.

**الكلمات المفتاحية:** مزرعة الدم؛ تلوث؛ المكورات العنقودية سالبة الكواجيوليز؛ المملكة العربية السعودية؛ الوحدات الجراحية

**Abstract**

**Objectives:** Contamination of blood samples can lead to serious problems in patient management. The administration of unnecessary antibiotics, wastage of hospital resources, and risks to patient life are some of the known hazards. This study aimed to calculate the rate of blood culture contamination and associated factors at King Khalid University Hospital (KKUH), Riyadh, KSA.

**Methods:** This is a retrospective cross-sectional study. The total study population was calculated based on a review of all of the request sheets for blood cultures submitted to the microbiology laboratory from 1st of January to 31st of December, 2012, at KKUH, Riyadh, KSA.

**Results:** The rate of blood culture contamination (false positive) was 1.9%, while 8.71% of the blood culture samples had true infections (true positive). *Coagulase negative staphylococcus* (*CoNS*) was the most predominant isolate (87%). The rate of blood culture contamination was significantly higher during the summer season of June (1.38%), July (3.97%) and August (3.72%) compared to other months of the year ($p$ value $< 0.05$). The surgical units in this study had the highest rate of

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blood culture contamination (3.92%), followed by intensive care (2.61%) and medical units (2.48%).

**Conclusion:** The rate of blood culture contamination at KKUH is within the acceptable international range. The highest rates of blood culture contamination occurred during the summer season and in the surgical units.

**Keywords:** Blood culture; *Coagulase negative staphylococcus*; Contamination; Saudi Arabia; Surgical units



## Introduction

Bacteraemia is defined as an invasion of the bloodstream by viable microorganisms and can be categorized as transient, intermittent, or persistent.[1] Bloodstream infections continue to be a major cause of mortality and morbidity in hospitalized patients despite advances in therapy and supportive care.[2–4] Bloodstream infections can be acquired in a community or in healthcare facilities, and the source of bacteraemia is classified as either primary, where there is no apparent source of infection, or secondary, which is due to infection in other sites of the body such as the respiratory, gastrointestinal, or integumentary systems.[5] Central line-associated bloodstream infection (CLABSI) is a major problem worldwide.[6,7] The prevalence of sepsis due to bacterial bloodstream infections in intensive care units (ICUs) remains high and is ranked as the 10th highest cause of death.[8–10] The associated 30-day mortality rate for community-acquired bloodstream infection ranges between 13 and 19%, and it is higher (30–50%) in ICU patients with sepsis.[11–13] For this reason, rapid and accurate detection of bacteraemia by blood culture is critical for improving the clinical outcomes of septic patients by starting the most appropriate antibiotics.[14] In recent years, several blood culture systems, such as BACTEC (BD Diagnostics, Sparks, USA) and the BacT/Alert system (Biomerieux, Nurtingen, Germany), have been developed that have high degrees of sensitivity and detect >95% of clinically significant bacteria in the blood within 48–72 h. Extension of the incubation of blood cultures to 5 days is recommended, and incubation beyond 5 days is indicated in cases where fastidious bacteria is suspected.[15,16]

Blood culture contamination continues to be a troublesome issue and has been a source of frustration for both medical microbiologists and clinicians for decades.[17] Contaminated blood cultures can cause difficulties in interpreting an actual positive blood culture, and this subsequently can lead to unnecessary treatment of the patient and can expose him to the side effects of a drug that he does not need. Prolonged hospital stays and unnecessary and costly care are additional issues.[18,19]

Blood culture contamination is defined as the recovery of normal skin flora (*coagulase-negative staphylococci*, *Propionibacterium* spp., *Aerococcus*, *Micrococcus*, *Bacillus* spp. [not *B. anthracis*], *Corynebacterium* spp. [diphtheroids], and alpha-hemolytic streptococci) from a single blood culture.[20] The rate of blood culture contamination is a recommended measurement of health care quality, and it should be continuously monitored to keep it within the international standard rate (not exceeding 2–3%).[21,22] Several studies have shown that proper use of an effective antiseptic measurement reduces the rate of blood culture contamination in health care; careful disinfection of the phlebotomy site with 70% ethanol is recommended, followed by application of chlorhexidine gluconate (30 s) as a skin antiseptic.[23,24] Other reports have documented significant reductions in the rate of blood culture contamination after implementing standardized practices for blood culture collection by a dedicated phlebotomy team and the use of blood culture collection kits.[2,25,26] Changing the needle before the inoculation of the blood culture bottle has a non-significant effect on the rate of blood culture contamination, and this practice will increase the risk of needle stick injury and exposure to blood-borne diseases.[27] Central venous catheters are colonized with organisms up to 25% of the time and can be a source of contamination; therefore, percutaneous collection of blood is preferred to avoid undesirable consequences of this practice.[28]

Targeting busy departments with high rates of blood culture contamination such as emergency rooms, paediatrics and surgery by implementing specific measures as a part of quality improvement interventions will reduce the rate of contaminated blood.[26]

Unfortunately there is a large gap in the current knowledge regarding blood contamination on Saudi Arabia. Thus, the objectives of our study were to calculate the rate of blood culture contamination during a study period from January 1 to December 31, 2012, at King Khalid University Hospital (KKUH), Riyadh, Saudi Arabia, and to identify factors associated with high rates of blood culture contamination.

## Materials and Methods

This study is a quantitative observational retrospective cross sectional study. We reviewed all of the blood culture samples submitted to microbiology laboratory from the 1st of January to the 31st of December in 2012. The study was conducted at King Khalid University Hospital (KKUH) affiliated with King Saud University, which is a 950-bed teaching hospital with a total of 125 new admissions per day. It serves as a primary, secondary and tertiary referral centre for more than one million inhabitants of Riyadh and nearby cities.

We reviewed all of the request sheets for blood culture submitted to the microbiology laboratory in 2012 at King Khalid University Hospital (KKUH) in Riyadh, Kingdom of Saudi Arabia. For all of the blood culture bottles received in the microbiology laboratory, we recorded the volume of blood in each bottle and then incubated them immediately in the automated blood culture machine, the BacT/Alert system (Biomerieux, Nurtingen, Germany). 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 given to the treating physician. Subsequently, the solid media was inoculated and incubated for 24 h. The automated MicroScan WalkAway-96 System was used to perform the final identification and antimicrobial susceptibility tests using Negative Combo 30 B1017-302 and Negative Combo 34 B1017-305 panels (Dade Behring, Sacramento, CA). The final report was issued if there was no growth after five days of incubation.

The total number of request sheets was 12,129. All microorganisms known to be true pathogens (e.g., *E. coli* and *Pseudomonas aeruginosa*) were excluded, and only the microorganisms that are commonly found on skin as normal flora were included in our study. Normally, human skin is colonized by common contaminants, including *Coagulase-negative Staphylococci*, *Bacillus* spp. *Corynebacteria*, and *Propionibacteria*.[29]

We defined the organism as a skin contaminant if one bottle grew any of the normal flora of the skin, and we isolated a single bottle out of two bottles. In addition, we considered the sample to be contaminated if one or two bottles out of four bottles grew normal flora.

The requisite sheet included hospital number, lab number, name of the unit, date the blood sample was received, type of bottle (aerobic/anaerobic), duration of detection of positive sample in days, and the isolated organism's identification.

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 the study period.

We applied international standards to calculate the rate of blood culture contamination.[17]

All of the data were collected in an Excel sheet and were analysed using SPSS 19.0 statistical software (SPSS Inc. Wacker Drive, Chicago, IL USA).[30]

This study was reviewed and approved by the KKUH Institution Review Board (IRB).

## Results

Of all the blood culture samples received (12,129) in the microbiology laboratory during the study period, 1287 (10.61%) were positive blood culture samples, including both real and contaminated blood cultures.

We found that 230 (1.9%) samples appeared contaminated (false positive), while 1057 (8.71%) samples had actual bacteraemia (true positive), as shown in Table 1.

Univariate analysis shows that the prevalence of blood culture contamination is significantly higher during the months of July–August and October ($p = 0.001$ and 0.014, respectively); see Table 2. We noticed that the rate of blood culture contamination was significantly higher during the summer season of June (1.38%), July (3.97%) and August (3.72%) compared to the other months of the year ($p$-value <0.05), as shown in Figure 1.

The surgical units in this study had the highest rate of blood culture contamination (3.92%), followed by intensive care units (2.61%) and medical units (2.48%), while the rate of blood culture contamination was lower in the paediatric and outpatient units ($p < 0.001$); see Table 3.

Table 4 shows that *Coagulase-negative Staphylococcus* (*CoNS*) was the most predominant isolate, with 201 cases (87%), followed by *Corynebacterium* species with 13 (5.65%) and *Micrococcus* species with five (2.17%). *Staphylococcus Epidermidis* was the most common isolated species of coagulase negative staphylococcus, with 97 cases (42.17%). Table 5 gives the distribution of blood culture contamination among hospital units.

**Table 1: The rate of blood culture positives and contamination per month.**

| Month | Total BC | Positive blood culture N (%) | Contaminant N (%) |
|---|---|---|---|
| January | 1093 | 124 (11.34) | 17 (1.56) |
| February | 977 | 112 (11.46) | 13 (1.33) |
| March | 1075 | 86 (8) | 13 (1.21) |
| April | 803 | 87 (10.83) | 10 (1.25) |
| May | 1097 | 53 (4.83) | 10 (0.91) |
| June | 944 | 87 (9.22) | 13 (1.38) |
| July | 1058 | 133 (12.57) | 42 (3.97) |
| August | 994 | 169 (17) | 37 (3.72) |
| September | 909 | 113 (12.43) | 15 (1.65) |
| October | 971 | 109 (11.23) | 22 (2.27) |
| November | 1057 | 90 (8.51) | 19 (1.80) |
| December | 1151 | 124 (10.77) | 19 (1.65) |
| Total | 12129 | 1287 (10.61) | 230 (1.90) |

## Discussion

Blood culture contamination determination is very critical for proper management of patients with bacteraemia and wise utilization of hospital resources. Reduction of blood culture contamination will lower the risk of patients' exposure to unnecessary antimicrobial agents and their side effects.[31]

We found that *Coagulase negative staphylococcus* (*CoNS*) was the most common bacteria isolated (87%), followed by other skin contaminants such as *Corynebacterium* species, *Bacillus* species other than *Bacillus Anthracis*, *Propionibacterium acnes*, *Micrococcus* species, and *Viridans group streptococci*. This is consistent with previous reports.[32,33]

The optimal rate of blood culture contamination has been determined to be 2–3% or less of the total blood cultures collected according to the international standards.[34] To achieve a low rate of blood culture contamination, several recommendations with regard to blood culture collection should be followed, including appropriate techniques and use of effective antiseptic agents.[35,36] In this study, the rate of blood culture contamination was 1.9%, which is less than the international accepted range.

**Table 2: Prevalence of blood contamination by month (univariate analysis).**

| Months | Contamination N (%) | PR (95% CI) | $p$-value |
|---|---|---|---|
| July–August | 79 (3.85) | 3.03 (2.22–4.14) | <0.001 |
| October | 22 (2.27) | 1.79 (1.12–2.86) | 0.014 |
| Other months | 76 (1.27) | Reference | |

PR, prevalence ratio; CI, confidence interval.

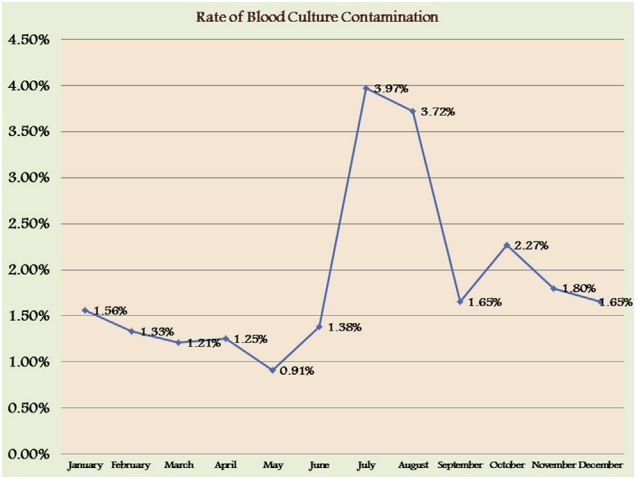


**Figure 1:** The rate of blood culture positives and contamination per month.

**Table 3: Prevalence of blood contamination by unit (univariate analysis).**

| Units | Contamination N (%) | PR (95% CI) | *p*-value |
|---|---|---|---|
| Surgery | 39 (3.93) | 6.42 (3.76–10.95) | <0.001 |
| Intensive care units and medicine | 118 (2.61) | 4.28 (2.67–6.87) | <0.001 |
| Emergency | 53 (1.58) | 2.55 (1.53–4.25) | <0.001 |
| Paediatrics and outpatient clinics | 20 (0.61) | Reference | |

PR, prevalence ration; CI, confidence interval.

To maintain a low rate of blood culture contamination, regular calculation and analysis of blood culture contamination is required. We analysed our contaminated blood samples to determine the most common microorganism isolated.

The best way to reduce and maintain low rates of blood culture contamination is to determine the locations and times

**Table 4: Distribution of organisms isolated from contaminated blood cultures.**

| Organisms | Contaminant N (%) | Real | Total |
|---|---|---|---|
| *Staphylococcus epidermidis* | 97 (42.17) | 83 (23.45) | 180 |
| *Coagulase Negative Staphylococcus* spp. | 46 (20) | 31 (19.13) | 77 |
| *S. hominis* | 38 (16.52) | 20 (12.34) | 85 |
| *S. haemolyticus* | 14 (6.08) | 13 (8.02) | 27 |
| *S. capitis* | 6 (2.60) | 4 (1.73) | 10 |
| *Corynebacterium diphtheriae* | 13 (5.65) | 5 (3.08) | 18 |
| *Micrococcus* sp. | 5 (2.17) | 2 (1.23) | 7 |
| *Bacillus* spp. | 5 (2.17) | | 5 |
| *Propionobacterium* | 1 (0.43) | 1 (0.61) | 2 |
| Others | 5 (2.17) | 3 (1.85) | 8 |
| Total | 230 | 162 | 392 |

**Table 5: The rate of blood culture contamination among various hospital units.**

| Unit | Contamination N (%) | Total |
|---|---|---|
| Paediatrics | 7 (0.77) | 904 |
| Surgery | 39 (3.92) | 993 |
| Medicine | 41 (2.48) | 1652 |
| Outpatient clinics | 15 (0.63) | 2364 |
| Emergency | 53 (1.58) | 3347 |
| Intensive care units | 75 (2.61) | 2867 |
| Total | 230 | 12129 |

that have higher rates of blood contamination compared to others. The rate of blood culture contamination is higher in emergency situations and with paediatric patients due to the difficulties encountered when drawing blood.[37] However, in our study, surgical units were found to have higher rates of contamination (3.93%) compared to the overall rates of blood culture contamination for the whole hospital during the study period. Our data do not allow us to further speculate on this finding. Further studies are needed to explore the high rate of contamination in the surgical unit.

In regards to the relationship between the time of the year and the rate of blood culture contamination, we found that summer months have higher rates of blood culture contamination, and this can be explained by the shortage of expert phlebotomists and nursing staff during this period.[26] Future studies are recommended to determine the relationship between the rate of blood culture contamination and the level of training of nursing staff and phlebotomists.

Because this study is a retrospective study, one of the drawbacks is the lack of clinical data due to poor documentation in the laboratory requisition sheet. Future studies with blood collection site visits and observation are recommended. The present study should also be supported by other research in different areas of Saudi Arabia, either by government or private facilities, making the result more generalizable in Saudi Arabia.

## Conclusion

Overall the rate of blood culture contamination at KKUH is within the acceptable international range, and among all units in the hospital, the surgical units were found to have the highest rate of blood culture contamination. During the summer months, blood culture contamination was significantly higher than that observed during the other months of the year.

## Conflict of interest

The authors have no conflict of interest to declare.

## Acknowledgements

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