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Research Article

Blood culture sampling in the central emergency room of the Department of Internal Medicine at Frankfurt am Main Northwest Hospital

Blutkultur-Entnahme in der zentralen Notaufnahme der Klinik für Innere Medizin des Krankenhauses Nordwest Frankfurt am Main

Abstract

The central emergency room is often the first point of contact for patients seeking microbiological diagnostics and anti-infective therapy. Blood cultures (BC) are currently (2025) the gold standard for pathogen diagnostics in human blood. In this retrospective study, staff training and the establishment of a standard operating procedure (SOP) for the collection of BC pairs were intended to achieve an adequate number of BC pairs collected (≥2 BC pairs), a reduction in the contamination rate, and a reduction in false-positive BC pairs in internal medicine patients who received anti-infective therapy in the central emergency room. The retrospective evaluation was conducted over three months (July–September) in 2024 and 2025. In June 2025, the SOP was established and staff training was conducted. A total of 325 patients were included in the comparison period (2024) and 289 patients in the intervention period (2025). It was shown that there was a significant increase (p=0.001) of 45.86% in adequately collected BC pairs (≥2 BC pairs) during the intervention period (2025). Furthermore, the intervention period (2025) showed a significant decrease (p=0.001) of 8.81% in inadequately collected BC pairs (<2) compared to the comparison period (2024). The contamination rate was reduced non-significantly (p<0.05) with p=0.010 from 13.37% (2024) to 7.52% (2025). Similarly, the proportion of false-positive BC pairs out of all positive BC pairs was reduced non-significantly (p=0.106) by 12.06% during the intervention period. This intervention study showed that staff training and an SOP for blood cultures can significantly improve microbiological preanalytics in terms of quality and quantity. This could contribute to improved patient care by avoiding unnecessary anti-infective therapies and enabling adequate pathogen diagnostics.

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Zusammenfassung

Die zentrale Notaufnahme ist für PatientInnen häufig die erste Instanz zur Einleitung einer mikrobiologischen Diagnostik und Antiinfektivatherapie. Blutkulturen (BK) stellen aktuell (2025) den Goldstandard der Erregerdiagnostik im menschlichen Blut dar. In dieser retrospektiven Untersuchung sollte durch Personalschulungen und Etablierung einer Standard Operating Procedure (SOP) zur Entnahme von BK-Paaren die Anzahl adäquat entnommener BK-Paare (≥2 BK-Paare), eine Reduktion der Kontaminationsrate und eine Reduktion falsch-positiver BK-Paare bei internistischen PatientInnen, welche eine Antiinfektivatherapie in der zentralen Notaufnahme erhalten haben, erreicht werden. Die retrospektive Auswertung erfolgte jeweils über drei Monate (Juli–September) 2024 und 2025. Im Juni 2025 erfolgten die Etablierung der SOP und die Personalschulungen. Insgesamt wurden 325 PatientInnen im Vergleichszeitraum (2024) und 289 PatientInnen im Interventionszeitraum (2025) eingeschlossen. Es konnte gezeigt werden, dass es im Interven-

tionszeitraum (2025) zu einer signifikanten Zunahme (p=0,001) der adäquat entnommenen BK-Paare (≥2 BK-Paare) um 45,86% kam. Weiterhin zeigte sich im Interventionszeitraum (2025) gegenüber dem Vergleichszeitraum (2024) eine signifikante Abnahme (p=0,001) der unzureichend-entnommenen BK-Paare (<2) um 8,81%. Die Kontaminationsrate konnte nicht-signifikant (p<0,05) mit p=0,010 von 13,37% (2024) auf 7,52% (2025) gesenkt werden. Ebenfalls konnte der Anteil der falsch-positiven BK-Paare von allen positiven BK-Paaren nicht-signifikant (p=0,106) um 12,06% im Interventionszeitraum gesenkt werden. Diese Interventionsstudie konnte zeigen, dass Personalschulungen und eine SOP zu Blutkulturen eine signifikante Verbesserung der mikrobiologischen Präanalytik in Form von Qualität und Quantität bewirken können. Dies könnte zu einer Verbesserung der Patientenversorgung beitragen, indem nicht indizierte Antiinfektivatherapien vermieden und eine adäquate Erregerdiagnostik ermöglicht werden.

1 Introduction

Blood cultures (BC) are currently the gold standard for diagnosing pathogenic microorganisms in the blood. They form the basis for detecting bloodstream infections [1]. The aim of blood cultures is to enable rapid and precise identification of the pathogen in order to initiate targeted anti-infective therapy. This approach can significantly reduce mortality, length of hospital stay, and associated treatment costs [2]. The following clinical situations or suspected diagnoses are indications for blood culture collection: sepsis, septic shock, fever of unknown origin (FUO), fever in neutropenia/aplasia, endocarditis, cyclic generalized infection (e.g., typhoid fever, brucellosis), severe localized infections, before any anti-infective administration in cases of systemic inflammation and catheter-, implant-, and artificial heart valve-associated infections [1], [3]. In addition, candidemia/fungemia and *Staphylococcus aureus* bacteremia are indications for taking blood cultures every 48 to 72 hours [4], [5]. In general, blood cultures should be taken when infection is suspected, regardless of fever or chills [1], [3], [6], [7]. Taking blood cultures during anti-infective therapy may also be useful in the absence of clinical convalescence and pathogen detection. However, this should be done immediately before the next administration of anti-infective agents in order to increase the probability of detection at the lowest anti-infective concentration [8], [9].

In general, a blood culture pair consists of an aerobic and an anaerobic bottle, each filled with a culture medium [3], [10]. At least two blood culture pairs (aerobic/anaerobic) should always be taken [1], [3], [7], [11], [12]. The detection rate can be significantly increased by taking a larger number of blood culture pairs [13]. According to current hygiene recommendations, it is no longer necessary to take samples from two different puncture sites [11]. When taking samples, care must be taken to ensure adequate hygiene in order to avoid any contamination. Depending on the study, the general contamination rate (proportion of contaminated blood cultures out of all microbiologically processed blood cultures) ranges between 5.7% [14] and 8.2% [15]. In the context of quality assurance, it is defined as a quality indicator [9]. Internationally, a contamination rate of less than 3% is targeted for blood cultures taken from peripheral veins [1]. Furthermore, the proportion of false-positive blood cultures among all positive blood cultures is relevant [1]. The proportion of false-positive blood cultures varies between 13.3% [14] and 47.8% [15].

Common microorganisms that are more likely to be considered contamination include: coagulase-negative staphylococci (CoNS), *Micrococcus* spp., *Propionibacterium acnes*, *Corynebacterium* spp., *Bacillus* spp. (not *B. anthracis*), α-hemolytic (green) streptococci [1]. However, the patient context, clinical situation, and medical history must always be taken into account, which is why the detection of these microorganisms should not automatically be considered contamination [1].

2 Methodology

The objectives of the intervention study at Northwest Hospital were to optimize blood culture collection (standardization of at least two blood culture pairs prior to anti-infective therapy), reduce microbiological contamination findings (contamination rate <3%), and improve pathogen diagnostics (reduction of false-positive blood culture pairs). Data collection was carried out retrospectively after approval by Northwest Hospital (July 8, 2025) in two periods: from July 1, 2024, to September 30, 2024, (three months) and from July 1, 2025, to September 30, 2025 (three months).

Patients had to meet the following three inclusion criteria:

1. Presentation at the internal medicine emergency department of Frankfurt am Main Northwest Hospital
2. Initiation of anti-infective therapy in the emergency department
3. Subsequent inpatient admission

For data collection, patients were retrospectively reviewed using the ORBIS hospital information system (HIS) based on the criteria. The data was evaluated and processed using Microsoft Excel 2024, Microsoft Word 2019, and Jamovi (statistics program).

Table 1: Total number of patients, mean, median, and standard deviation for cases with <2 BC, ≥2 BC, and no BC in the respective study periods 2024 and 2025

	Investigation period	<2 BC	≥2 BC	None BC
N (number of patients)	**2024**	325	325	325
	2025	289	289	289
Missing	**2024**	0	0	0
	2025	0	0	0
Mean	**2024**	0.492	0.209	0.298
	2025	0.121	0.668	0.211
Median	**2024**	0	0	0
	2025	0	1	0
Standard deviation	**2024**	0.501	0.407	0.458
	2025	0.327	0.472	0.409
Minimum	**2024**	0	0	0
	2025	0	0	0
Maximal	**2024**	1	1	1
	2025	1	1	1

Prior to the intervention period from July to September 2025, an intervention took place in the form of the creation and establishment of an SOP for paired blood culture collection (structural indicator) and several training sessions for nursing and medical staff (process indicator) on paired blood culture collection in the central emergency room (see SOP in Attachment 1).

3 Results

In order to statistically record the influence of the intervention (training + SOP), the Chi²/χ^2 test was performed in addition to descriptive statistics. Cramér's V was calculated to record the effect size. The significance level was set at α=0.05.

Between July and September 2024, a total of 1,261 patients were examined in detail, of whom 325 were included in the study. In 160 (49.23%) patients, fewer than two pairs of blood cultures were taken. In 68 (20.92%) patients, two or more pairs of blood cultures were taken before anti-infective therapy. No blood culture pairs were taken from 97 (29.84%) patients prior to anti-infective therapy. Thus, 257 (79.07%) patients did not receive the recommended pathogen diagnostics prior to anti-infective therapy. From July to September 2025, a total of 1,402 patients were examined in detail, of whom 289 were included. In 35 (12.11%) patients, fewer than two pairs of blood cultures were taken. In 61 (21.1%) patients, no pairs of blood cultures were taken before anti-infective therapy. In 193 (66.78%) patients, two or more pairs of blood cultures were taken before anti-infective therapy (see Table 1).

The analysis showed that there was a significant increase (p=0.001) of 45.86% in adequately collected blood culture pairs (≥2 BC pairs) in the intervention period (2025) compared to the comparison period (2024). The effect size (Cramér's V) for the comparison was 0.463, indicating a strong effect of the intervention. Furthermore, during the intervention period (2025) compared to the reference period (2024), there was a significant decrease (p=0.001) in inadequately collected blood culture pairs (<2) of 8.81%. The effect size (Cramér's V) for the comparison was 0.398, indicating a moderate to strong effect of the intervention. In addition, a significant decrease (p=0.013) of 8.74% in completely missing blood culture pairs was demonstrated in the intervention period (2025) compared to the comparison period (2024) (see Table 1).

In the comparison period (2024), a total of 299 blood culture pairs were collected. Of these, 40 blood culture pairs were assessed as contaminated. This corresponds to a contamination rate of 13.37%. The proportion of false-positive blood culture pairs out of all positive blood culture pairs (84) was 47.61%. During the intervention period (2025), a total of 425 blood culture pairs were collected. Of these, 32 were assessed as contaminated. This results in a contamination rate of 7.52% (see Table 2).

The proportion of false-positive blood culture pairs out of all positive blood culture pairs (90) was 35.55%. The reduction in the contamination rate from 13.37% (2024) to 7.52% in the intervention period reached the significance level (α=0.05) with p=0.010. The 12.06% reduction in false-positive blood culture pairs out of all positive blood culture pairs was not significant (p=0.106) (see Table 3).

4 Discussion

Blood cultures remain the gold standard for diagnosing pathogenic microorganisms in the blood [1] and are indispensable (as of 2025) for the fastest possible identification of pathogenic organisms in the blood and for adequate and targeted anti-infective therapy.

This study showed that in the first study period (July to September 2024), 79% of patients did not have adequate blood cultures taken (<2 BC pairs or no BC taken) before

Table 2: Total number of BC, mean, median, and standard deviation of contaminated and correct positive BC in the respective study periods 2024 and 2025

	Investigation period	Contaminated BC	Correct positive BC
N (number of patients)	2024	299	299
	2025	425	425
Missing	2024	0	0
	2025	0	0
Mean	2024	0.134	0.147
	2025	0.0753	0.136
Median	2024	0	0
	2025	0	0
Standard deviation	2024	0.341	0.355
	2025	0.264	0.344
Minimum	2024	0	0
	2025	0	0
Maximal	2024	1	1
	2025	1	1

Table 3: Total number of positive BC. Mean, median, standard deviation of false-positive BC in the respective period

	Investigation period	False positive BC
N (number of patients)	2024	84
	2025	90
Missing	2024	0
	2025	0
Mean	2024	0.476
	2025	0.356
Median	2024	0.00
	2025	0.00
Standard deviation	2024	0.502
	2025	0.481
Minimum	2024	0
	2025	0
Maximal	2024	1
	2025	1

starting anti-infective therapy in the emergency room. This significantly reduces pathogen identification with possible relevant consequences for the further care of patients [16]. In our study, training of nursing and medical staff and the establishment of an SOP for blood culture pair collection resulted in a significant increase (p=0.001) of 45.86% in adequately collected blood culture pairs (≥2 BC pairs). The effect size (Cramér's V) was rated as strong at 0.463. Furthermore, compared to the reference period, a significant (p=0.001) decrease of 8.81% in inadequately collected blood culture pairs (<2) was achieved during the intervention period. The effect size (Cramér's V) was rated as moderate at 0.398. The intervention also significantly (p=0.013) reduced the complete absence of blood culture pairs (0 blood culture pairs collected) before the initiation of anti-infective therapy by 8.74%. We were thus able to demonstrate that our interventions resulted in a significant improvement in blood culture pair collection. This supports the results of a study by Dutta et al., which showed that training emergency room staff led to an increase in blood culture pair collection with an increased positivity rate of blood cultures [17].

The contamination rate was also significantly reduced (p=0.010) by 5.85% to 7.52%, and the false-positive blood culture pairs were reduced non-significantly (p=0.106) by 12.06% to 35.55%. This could be due to the establishment of the SOP, which explicitly emphasizes compliance with hygiene measures and the use of blood culture adapters when collecting blood cultures. International studies have already shown that various blood culture adapters can significantly reduce the contamination rate [18], [19]. Internationally, a contamination rate of <3% of blood cultures is the target [1], but unfortunately, our intervention was unable to achieve this.

The high turnover of nursing and medical staff in the emergency room poses a significant challenge to ensuring consistent, high-quality standards of care. The regular

turnover of nursing and medical staff in the internal medicine department of the central emergency room at Northwest Hospital may also have contributed to the observed differences in results due to varying levels of knowledge regarding anti-infective therapy, the handling of blood cultures, and varying medical experience. Regardless of the results, only the total number of blood cultures taken, the number of positive blood cultures, and the contamination rate could be used for quality assurance. Direct verification or control of the implementation of the SOP (e.g., compliance with hygiene measures, use of blood culture adapters, sufficient filling quantity per blood culture bottle, etc.) was not possible due to the personnel required for this. Further ongoing training and recommendations for action are therefore necessary to achieve further improvement.

In summary, it has been shown that establishing SOPs and providing ongoing education for medical and nursing staff can optimize blood culture collection (≥2 BC pairs) prior to anti-infective therapy and reduce the contamination rate and false-positive blood cultures. This could contribute to improving patient care in the future by avoiding unnecessary anti-infective therapies and enabling adequate pathogen diagnostics. This could reduce antibiotic-associated harm [20] and additional costs due to prolonged hospital stays [21]. In addition, the implementation of blood culture adapters (see SOP in Attachment 1) could reduce the risk of self-injury among staff, although there are currently no evidence-based studies available on this. Further scientific research is therefore needed to continuously improve the infectious disease and microbiological aspects of preanalytics.

5 Conclusion

In summary, it has been shown that establishing SOPs and providing ongoing education for medical and nursing staff can optimize blood culture collection (≥2 BC pairs) prior to anti-infective therapy and reduce the contamination rate and false-positive blood cultures. This could contribute to improving patient care in the future by avoiding unnecessary anti-infective therapy and enabling adequate pathogen diagnosis. This could reduce antibiotic-associated harm [20] and additional costs due to prolonged hospital stays [21]. In addition, the implementation of blood culture adapters (see SOP in Attachment 1) could reduce the risk of self-injury among staff, although there are currently no evidence-based studies available on this. Further scientific research is therefore needed to continuously improve the infectious disease and microbiological aspects of preanalytics.

Abbreviations

- BC: blood culture/blood culture pair
- FUO: fever of unknown origin
- HIS: hospital information system
- SOP: standard operating procedure

Notes

Competing interests

The author declares that he has no competing interests.

Attachments

Available from https://doi.org/10.3205/lab000051

1. lab000051_Attachment1.pdf (102 KB)
   SOP: Taking blood cultures from inpatients – Internal Medicine – Central Emergency Room – Northwest Hospital

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