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Quality improvement project

Improving Blood Culture Collection before Antibiotic Administration in Patients with Suspected Sepsis

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ABSTRACT

Objective: To assess baseline compliance with pre-antibiotic blood culture collection and evaluate the effect of targeted quality improvement interventions among patients with suspected sepsis.

Methods: This was a prospective observational study for quality improvement carried out at Ayub Teaching Hospital Abbottabad, between April 2026 and June 2026. There were 200 patients included who presented with suspected sepsis. Demographic features, timing of blood culture collection, use of antibiotics and factors associated with delay were recorded. Baseline compliance was evaluated and interventions like staff training, reinforcement of sepsis protocols and improved communication between lab and clinical services were implemented. Descriptive analysis was used to assess post-intervention compliance.

Results: Blood cultures were taken prior to antibiotic initiation in 118 of 200 patients (59%), 52 of 200 patients (26%) had blood cultures taken after antibiotic initiation, and 30 of 200 patients (15%) had no blood culture testing. The most frequent factors influencing delays in collection were delays in clinical decision-making (27%), emergencies workload (24%), and lack of knowledge of protocol (19%), laboratory-related delays (16%), and incomplete documentation (14%). After quality improvement, blood culture collection before antibiotics went from 59% to 82%.

Conclusion: Targeted quality improvement interventions were effective in increasing compliance with blood culture collection prior to antibiotic administration in patients suspected with sepsis. To improve the early diagnosis of sepsis and appropriate antimicrobial therapy, it is important to strengthen diagnostic stewardship, improve staff awareness and optimise clinical workflows.

INTRODUCTION

Blood Cultures are crucial for the identification of causative pathogens to guide antimicrobial therapy, but the need to initiate antibiotic treatment quickly, often within a few hours of admission to hospital, can create a conflict between the need to obtain blood cultures and the need to start treatment promptly (Berninghausen et al., 2024; Rhodes et al., 2017). Low volume filling and not collecting multiple sets are just two of these inconsistencies that significantly decrease the reliability of diagnostic yield in the acute care setting (Abdi et al., 2025). In addition, studies have suggested that the time of blood culture collection after the initiation of broad-spectrum antibiotic therapy is also an important factor because blood cultures collected following antibiotic therapy may significantly underestimate the likelihood of pathogen detection (Cheng et al., 2019). In response, prospective studies have tested the effect of different sampling methods (e.g., multi-sampling versus single-site venipuncture) to maximize detection of pathogens (Yu et al., 2020). In addition to these technical issues, data indicates that as many as 42% of treatment pathways for sepsis may be unnecessary for non-infectious disease, showing the potential for unnecessary antimicrobial use (Li et al., 2026). Current diagnostic stewardship models suggest that integration of EDS in clinical decision making can help to guide clinicians through the best available evidence to increase the sensitivity of microbiological findings (Gupta et al., 2026; Kusnik et al., 2026). In addition, using multimodal interventions, like real-time telemedicine monitoring, has been found to be effective in closing workflow gaps by signaling the clinical team to bundle elements that are yet to be completed, such as timely lactate measurement and culture collection (Palagiri et al., 2026). Recent research on diagnostic stewardship has shown that intensive feedback loops, combined with clinical decision algorithms, can greatly improve compliance with these standardized processes in academic EDs (Seidelman et al., 2023; Theophanous et al., 2025). These programs are complemented by de-escalation diagnostic stewardship programs that focus on minimizing low yield testing in clinical situations with a low likelihood for bacteremia (Claeys & Johnson, 2023; Seidelman et al., 2023). These strategies are important for high levels of contamination, which have been estimated to be between 0.6% and 12.5% in hospital settings (Lubin et al., 2021).Diagnostic stewardship programs are essential to antibiotic stewardship programs, because they allow for the shift from empiric to narrow-spectrum antibiotic therapy when the correct microorganisms are identified (Rothe et al., 2019). These efforts will limit unnecessary antimicrobial exposure and diagnostic delays because they are not used in every patient.These efforts will effectively limit antimicrobial exposure and diagnostic delays as they are not used in every patient but in the clinically appropriate patient (Kim, 2025). In addition to reducing contamination, CDSS interventions have been found to reduce the number of unnecessary uses (Takkavatakarn et al., 2025), and one model showed that it could reduce the daily volume of blood cultures while simultaneously improving the diagnostic yield. Moreover, the implementation of alerts for clinical decision support within the EHR system has proven to be effective in improving timely collection rates among the patients where the infection is suspected, and intravenous antibiotic therapy needs to be initiated promptly (Dutta et al., 2022). These predictive tools can help reduce the economic and clinical impacts of over-testing and false positive results by optimizing patient selection and streamlining collection workflows (Fabre et al., 2021; Zhou et al., 2023). Likewise, the use of initial-specimen diversion devices has increased and has been shown to decrease the amount of skin flora introduced into culture media and to further stabilize the accuracy of the diagnosis (Povroznik, 2025). These devices have been consistently linked to reduced contamination and enhanced overall quality of care (Callado et al., 2023), as they isolate the initial 1-2 mL of blood, typically comprising microorganisms from the skin. These analytical advances are complemented by the shift to 24/7 blood culture processing, which includes the use of automated blood culture systems and further shortens the time-to-result (TTR) for Gram-stain and species identification (Wang et al., 2026). Moreover, automating sample processing, like VPlus 50 and Vitek 2 XL, has been shown to enhance the efficiency of laboratory workflows without compromising the diagnostic accuracy of the results (Qin et al., 2025). Simultaneously, the development of "smart antibiograms" with real-time access to existing cumulative antibiotic profiling data enables self-updated logic to adjust susceptibility rules according to resistance trends in the local environment (Testing et al., 2018). Further research is needed to assess the long-term clinical and economic outcomes of these integrated stewardship strategies in various healthcare contexts (Banerjee & Humphries, 2021). In addition, decentralized laboratory workflows, including the strategic deployment of an automated loading system at the point of care, can provide further opportunities to reduce time-to-result, eliminating transit time. But the effect of these technological advances is only realized when combined with active antimicrobial stewardship interventions (Banerjee et al., 2020). Research shows that reporting the diagnostic results alone does not have as much

impact on the patient as utilizing rapid pathogen identification coupled with stewardship-driven clinical intervention (Florio et al., 2018). The most important therapeutic advances are therefore realized in institutions with 24/7 availability of multi-disciplinary teams to quickly convert positive outcomes into immediate evidence-informed medication changes (Schneider et al., 2019). In addition to identification, the combination of rapid diagnostic testing and proactive stewardship programs has been found to decrease mortality rates and to promote the shift to optimal therapy (Agnetti et al., 2023; Baum et al., 2025). Additionally, diagnostic stewardship subgroups should be included in these programs to ensure molecular results are interpreted correctly and communicated in a timely fashion to the primary clinical team (Wagner et al., 2021). The evidence from randomized controlled trials demonstrates that in addition to providing a mechanism for detecting pathogens and resistance markers, rapid diagnostics also require a mechanism of active and audit-based oversight to reduce risks of mortality (Mudenda et al., 2025; Zeitler & Narayanan, 2019). Furthermore, these systems need to be continuously innovated and interprofessional collaboration between clinical professions, such as microbiology, pharmacy, and nursing, is crucial to achieve the greatest value from diagnostic investments (Ryu et al., 2023). Cooperation is especially important in low-to-middle income countries, where resources are scarce and strategic, data-driven implementation is needed to ensure the investments in diagnostics are translated into meaningful reductions in antimicrobial resistance and improved healthcare expenditure (Jinks et al., 2024; Moore et al., 2023).

Research gap

Although studies on diagnostic stewardship are emerging, very little is known about adherence to pre-antibiotic blood culture collection practices in tertiary care hospitals in Pakistan. Hence, this study aims at evaluating the existing situation, finding the barriers, and testing the effectiveness of quality improvement interventions at Abbottabad Teaching Hospital.

Objectives

1. To determine the current compliance with obtaining blood cultures before antibiotic therapy is started in patients with suspected sepsis.
2. To find out what obstacles and factors can cause delays or failure to collect blood cultures before giving antibiotics.
3. To implement and assess interventions to improve timely collection of blood cultures prior to antibiotics and to improve outcomes of sepsis management.

Material and Methods

Study Design and Setting

A prospective observational quality improvement study was carried out at Ayub Teaching Hospital Abbottabad, during April – June 2026 to assess and enhance the practice of the collection of blood culture before antibiotic use in patients who were suspected to have sepsis. The study aimed to evaluate current clinical practices, non-compliance and interventions to enhance timely blood culture collection prior to starting antibiotic treatment.

Study Population and Sample Size

All 200 patients with suspected sepsis seen during the study period were included in the study. Patients were identified from the appropriate hospital departments such as emergency, medical and intensive care unit where sepsis management was regularly carried out. This study included patients who met clinical criteria for suspected sepsis and needed empirical antibiotic treatment for their treatment.

Inclusion and Exclusion Criteria

The study included all patients of any age with clinical suspicion of sepsis who were treated with IV antibiotics. Patients were included if blood cultures were indicated as part of their initial sepsis evaluation. Patients who had already been started on antibiotics prior to hospital presentation, those who had incomplete clinical details and patients where there was no clinically indicated blood culture were excluded from the study.

Data Collection Procedure

Data were gathered from a structured data collection form designed based on the study objectives. Data on patients' characteristics, clinical presentation, and time of sepsis detection, blood culture and antibiotic administration were collected. The time from blood culture collection to antibiotic administration was evaluated to evaluate adherence to recommended sepsis management.

Assessment of Current Practice

The practice of blood culture collection prior to antibiotic use was assessed in the enrolled patients. Medical records and laboratory results were examined to see if blood cultures were taken before the use of antibiotics. Causes of delay in sample collection or inconsistencies in documentation and/or deviation from standard procedures were identified and analysed.

Intervention and Quality Improvement Measures

Improvement strategies were put in place to increase compliance with pre-antibiotic blood culture collection based on the identified gaps. These measures included educating healthcare staff, reinforcing sepsis management protocols, holding awareness sessions on the importance of taking blood cultures promptly, and improving communication between clinical and laboratory staff. The effectiveness of these interventions was measured during the period of the study.

Data Analysis

The obtained data was entered and statistically analysed with the corresponding method. Patient characteristics and compliance rates were described by means of descriptive statistics. A blood culture before antibiotic therapy was performed was computed and factors associated with failure to do so were assessed. Results were reported as frequencies, percentages, tables and graphs as appropriate.

Ethical Considerations

All the necessary institutional review committee (IRC) approvals were received prior to the start of the study. Confidentiality and privacy of patients were preserved during the research process. The study was carried out on the basis of ethical principles for clinical research and the data were collected and analysed anonymously. The findings were supposed to help to improve the sepsis care practices and increase patient safety at Abbottabad Teaching Hospital.

RESULTS

4.1 Demographic and Clinical Characteristics of Study Participants

The study was conducted in Ayub Teaching Hospital Abbottabad, from April 2026 to June 2026 and included a total of 200 patients who were suspected of having sepsis. Demographic and clinical data of the subjects were analysed. Most patients were in the adult age group and slightly more males than females. The majority were admitted via the ED and medical units, indicating the urgent nature of the majority of patients with suspected sepsis. Common clinical features included fever, hypotension, altered mental status and elevated inflammatory markers.

Table 4.1: Demographic Characteristics of Study Participants

Variables	Frequency (n)	Percentage (%)
Age group		
<18 years	28	14.0
18–40 years	62	31.0
41–60 years	68	34.0
>60 years	42	21.0
Gender		
Male	118	59.0
Female	82	41.0
Department of Admission		
Emergency Department	86	43.0
Medical Unit	78	39.0
Intensive Care Unit	36	18.0

Table 4.1 shows the demographic characteristics of the 200 patients who were included in the study. The results revealed that the age group of 41-60 years (34%) had the highest number of patients with suspected sepsis, followed by 18-40 years (31%). This suggests that suspected sepsis was more common in middle aged and elderly adults. The patients aged over 60 years represented 21% and those younger than 18 years represented 14% of the study population. In terms of gender, there were more males (59%) than females (41%) and more suspected sepsis cases in males than females. The Emergency Department had the largest number of cases (43%) followed by the Medical Unit (39%) and Intensive Care Unit (18%) in terms of admission departments. The results revealed the significance of the early identification of sepsis and prompt diagnostic management, especially in emergency and medical care settings, for baseline compliance with blood culture collection before antibiotics.

Table 4.2: Blood Culture Collection Status before Antibiotic Administration

Blood Culture Status	Frequency (n)	Percentage (%)
Blood culture collected before antibiotics	118	59.0
Blood culture collected after antibiotics	52	26.0
Blood culture not collected	30	15.0
Total	**200**	**100**

Table 4.2 shows the compliance with blood culture collection before antibiotic administration for all patients who were suspected of sepsis. Blood cultures were obtained prior to antibiotic use in 118 of 200 patients (59%) with a blood culture, reflecting the use of more than half of patients in the study in accordance with the recommended clinical practice. There were, however, 52 patients (26%) who were prescribed antibiotics prior to blood culture samples were taken, which may decrease the chances of identifying the pathogen and could impact targeted antimicrobial therapy. In addition, 30 patients (15%) did not have blood culture testing, which may indicate a lack of compliance with standard sepsis management practices. These results show that although blood culture was performed in many cases, there was a need for much improvement to guarantee prompt culture collection before the time of antibiotic initiation.

Figure 4.1: Compliance Rate of Blood Culture Collection before Antibiotics

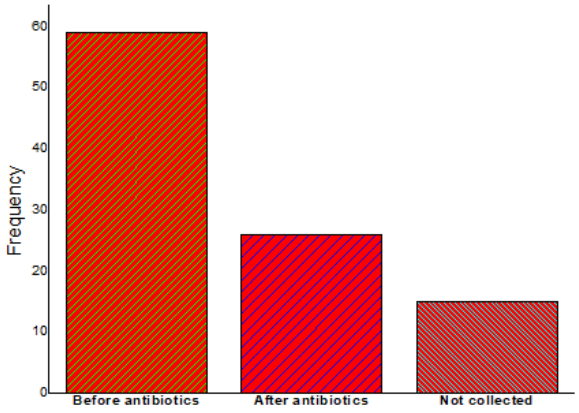


Figure 4.1 shows the distribution of compliance with the procedure of obtaining blood culture prior to antibiotic treatment. This figure illustrates that 59% of patients were taken for blood culture prior to antibiotic use, which is the proportion of patients managed in line with recommended practice. A large number of cases, however, were done too soon (26%) and too late (15%), as no blood culture was taken; 15% of patients were not given antibiotics. This trend suggests that there were still some significant problems with delay and opportunity missed in microbiological diagnosis in sepsis management. The results highlight the importance of structured interventions, staff awareness and protocol-based methods to enhance compliance in timely blood culture collection.

Table 4.3: Time Interval between Blood Culture Collection and Antibiotic Administration

Time Interval	Frequency (n)	Percentage (%)
Within 30 minutes	72	36.0
30–60 minutes	46	23.0
More than 60 minutes	52	26.0
Blood culture not obtained	30	15.0
Total	200	100

Table 4.3 shows the delay in time between the collection of blood culture and antibiotic administration for the participants in the study. Only 72 patients (36%) had blood cultures taken within 30 minutes, which is the best time for microbiological diagnosis. In another 46 patients (23%), a culture was obtained within 30 to 60 minutes and in 52 patients (26%), a culture was obtained in more than 1 hour. Furthermore, blood culture was not performed in 15% of the patients. The results show that blood culture was performed in many cases but that there were still delays in sample collection. Long delays can affect culture quality and delay timely treatment decisions, making the need for timely coordination between health care teams even more critical.

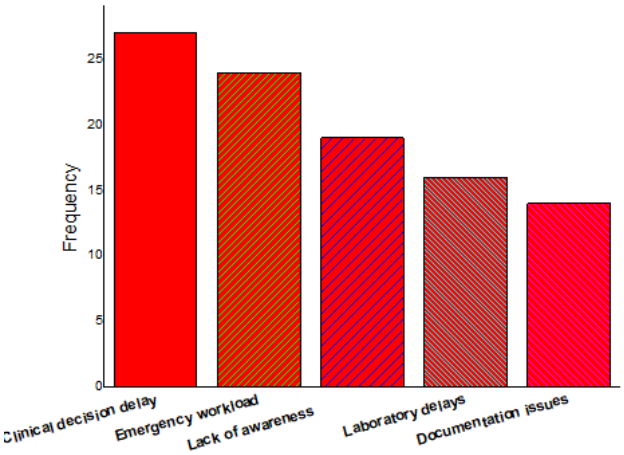
Table 4.4: Identified Barriers to Blood Culture Collection before Antibiotics

Identified Barrier	Frequency (n)	Percentage (%)
Delay in clinical decision-making	54	27.0
Emergency workload	48	24.0
Lack of awareness regarding protocol	38	19.0
Laboratory-related delays	32	16.0
Incomplete documentation	28	14.0

The major factors that contribute to delayed or missed blood culture collection before antibiotic administration are identified in table 4.4. However, the most common barrier was delay in clinical decision making (27%), which indicated that delayed clinical decision making in suspected sepsis cases impacted timely sample collection. Emergency workload was the second large barrier (24%), suggesting that high numbers of patients and emergency clinical needs affected compliance. 19% of the

cases were due to lack of awareness of sepsis protocols, highlighting the need for healthcare professionals to be educated and trained continuously. Other delays (16%) and improper documentation (14%) were also cited as factors. The results show that in general, issues related to both the organization and knowledge impeded timely blood culture practices.

Figure 4.2: Major Barriers Affecting Blood Culture Collection



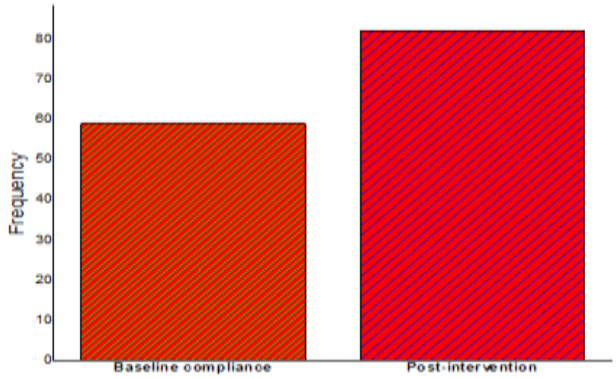
The relative contribution of different barriers to blood culture collection before antibiotic administration is highlighted in figure 4.2. As shown in the figure, clinical decision making delays and emergency workload were the most significant factors and shared over 50% of the factors identified. Knowledge related problems, such as lack of knowledge of sepsis protocols, also played a major role in the non-compliance. The results indicate that optimisation of clinical workflow, adequate training of staff and effective communication between the healthcare team and laboratory staff may be important in reducing delays and optimising blood culture practices.

Table 4.5: Comparison of Blood Culture Compliance before and After Intervention

Assessment Phase	Blood Culture Before Antibiotics (n)	Compliance (%)
Baseline assessment	118/200	59.0
After intervention	164/200	82.0

Table 4.5 shows compliance rates before and after implementing quality improvement interventions. At baseline, 118/200 (59%) patients had blood cultures taken prior to antibiotic use. Interventions including staff education, reinforcement of sepsis protocols and better liaison between clinical and laboratory teams led to an improvement in compliance to 164 from 200 patients (82%). That's an impressive 23 percentage-point increase from the previous year in following the recommended blood culture practices. The results show that specific quality improvement interventions were successful in improving the collection of blood cultures within a reasonable timeframe and compliance with sepsis management.guidelines.

Figure 4.3: Improvement in Compliance after Intervention



The results of the blood culture collection compliance are shown in Figure 4.3, which represents the improvement after the implementation of quality improvement measures. The figure represents the percentage of participants who complied with the protocol at baseline (59%) and following intervention (82%), highlighting the positive effect of educational and organizational strategies. The improvement indicates that the problem of major barriers in the collection of blood culture was successfully dealt with by raising the awareness of healthcare staff, reinforcing the protocol, and improving the coordination between clinical and laboratory departments. The results of this study are consistent with the success of structured interventions in improving early sepsis diagnosis and improving outcome for the management of sepsis.

DISCUSSION

The current study aimed at measuring the compliance of the antibiotic use before blood culture collection in patients with suspected sepsis at Ayub Teaching Hospital Abbottabad and the effects of quality improvement on the compliance. During the study period from April 2026 to June 2026, 200 patients were

recruited, and from the baseline evaluation, it was noted that blood cultures were taken prior to antibiotic administration in 59% of patients. This discovery suggests that although over half of the patients were diagnosed appropriately, a significant percentage were delayed or not collected for culture. These difficulties have been previously described in other studies, for instance, the emergency department (ED) in many cases has to balance the need for swift antibiotic administration with timely microbiological diagnosis [1]. Emphasized that there are often missed opportunities in emergency departments for blood culture collection, related to competing clinical priorities and workflow issues. The study results indicated that 26% of the patients were prescribed antibiotics prior to obtaining a blood culture, which could decrease the detection of pathogens and limit the options for targeted antimicrobial therapy. The importance of time of blood culture collection in relation to antimicrobial use on the likelihood of recovery of a pathogen has been highlighted previously [3] which found that taking blood culture before giving antimicrobials can significantly reduce likelihood of pathogen recovery and therefore the microbiological diagnosis of sepsis. Likewise, [4] pointed out that procedural inconsistencies, such as improper collection and non-standardized sampling procedures, can adversely affect blood culture results. Therefore, further efforts to enhance the quality of the blood cultures collected prior to antibiotic administration are still needed for correct diagnosis and proper antimicrobial stewardship.The most common barriers in the present study were delayed decision making in the clinic (27%), emergency workload (24%), lack of knowledge about protocol (19%), laboratory delays (16%) and incomplete documentation (14%). The results indicate both organizational and knowledge-based factors were associated with non-compliance. Our work is consistent with prior studies highlighting the value of interventions for improving blood culture practices, such as staff education, clinical decision support systems, and standardized workflows. [7] found that clinical decision support interventions increased the collection of blood culture before giving IV antibiotics in emergency departments. In addition, [8] found that diagnostic stewardship interventions and blood culture algorithms helped to increase the appropriate use and implementation of recommended blood culture collection practices. The results of this study validate the continued training and workflow optimization within hospital environment.After the quality improvement strategies were implemented, compliance in the present study increased from 59% at baseline to 82% after intervention, when staff education, reinforcement of sepsis protocols, and the enhancement of communication between clinical and laboratory teams were used. This improvement is an example of the impact of structured interventions on improving timely collection of blood cultures. These results have been seen in trials assessing diagnostic stewardship methods. Highlighted that the use of diagnostic stewardship bundles can promote adherence to evidence-based antimicrobial stewardship, thereby enabling timely antimicrobial treatment. Moreover, [25] described that optimizing blood culture processes enhanced clinical outcomes and healthcare efficiency in managing blood stream infections. Thus, the results obtained in the present study underscore the importance of targeted quality improvement interventions to improve sepsis diagnostic pathways and aid better antimicrobial management.

CONCLUSION

The present study found that collection of blood culture prior to antibiotic use was sub-optimal, as only 59% of patients with suspected sepsis had blood culture collected before implementation of improvement strategies at Ayub Teaching Hospital Abbottabad. A number of factors were noted as barriers to an effective diagnosis of sepsis and prompt antibiotic administration, including delays in obtaining blood cultures, giving antibiotics prior to blood culture, and not obtaining blood cultures. The main factors were delays in clinical decision making, workload in the emergency department, lack of information on protocols, delays in laboratory tests, and documentation problems. To improve compliance with blood culture practices, interventions such as educating healthcare staff on the importance of blood culture, reinforcing sepsis protocols, and enhancing the coordination between clinical and laboratory teams were implemented, with the overall result being an improvement in compliance to 82% after their implementation. The results highlight the need for ongoing diagnostic stewardship initiatives to promote early pathogen detection, improve antimicrobial management, and improve the quality of sepsis care.

RECOMMENDATIONS

This study suggests that hospitals should develop and maintain consistent sepsis protocols which require blood cultures to be taken before antibiotic therapy is started whenever possible.

Training and awareness sessions should be organised regularly for Health Care Professionals including Emergency units and Medical unit's staff to enhance their knowledge of the value of prompt collection of blood culture. To decrease delays in sample processing and reporting, there should be better communication between clinical teams and microbiology laboratories in hospitals. Consider implementing electronic clinical decision support, sepsis checklists, or monitoring audits to ensure adherence to recommended practices. Regular monitoring of the rates of blood culture collection and regular quality improvement initiatives are recommended to maintain improvement and ensure that patients with suspected sepsis receive the best care for effective antimicrobial stewardship.

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Availability of data and materials:

The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Authors Contribution

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Final Approval of version- All Authors

All authors contributed significantly to the study's conception, data collection, analysis, Manuscript writing, and final approval of the manuscript as per Criteria.

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