Research Article

Frequency of Rejected Samples in the Hematological Departments: A Comparison Between Palestinian Medical Complex Hospital and Hebron Governmental Hospital

Lubna Mahmoud Habis[1], Mahmoud A. Srour[1,2], Ola Karmi[1*]

[1]*Master's program in Clinical Laboratory Science, Faculty of Pharmacy, Nursing and Health Professions, Birzeit University, Birzeit, Palestine*

[2]*Biology and Biochemistry Department, Faculty of Science, Birzeit University, Birzeit, Palestine*

Article Info

[*]***Corresponding Author:***
Ola Karmi
Master's program in Clinical Laboratory Science, Faculty of Pharmacy, Nursing and Health Birzeit University, Birzeit, Palestine
E-mail: okarmei@staff.birzeit.edu
ORCID ID: 0000-0002-8684-7039

Keywords

Rejected Samples, Preanalytical Errors, Turnaround Time (TAT), Hematology laboratories, Na-citrate blood samples, EDTA blood samples, Laboratory quality

Abstract

Background: Clinical laboratories play a vital role in diagnosis and management of patients. They use established protocols for sample collection and analysis, and several criteria to judge the quality of clinical samples intended for laboratory analysis. Two essential performance measures recommended for clinical laboratories are rejected samples and turnaround time (TAT), which have substantial clinical consequences for patient safety. This study evaluates these two measures in the hematological departments among the two biggest Palestinian Governmental Hospitals in the West Bank region, the Palestinian Medical Complex Hospital (PMCH), and the Hebron Governmental Hospital (HGH). This study is the first one to evaluate the rejected samples from Palestinian governmental hospitals.

Methods: A retrospective analysis of rejected hematology samples was conducted over eight months (February–September 2023). Rejection frequencies, causes, and their influence on TAT were assessed according to the Ministry of Health guidelines.

Results: PMCH exhibited a significantly higher rejection rate (2.1%) than HGH (1%), primarily due to clotted EDTA and Na-citrate tubes. The TAT for rejected samples was longer at HGH (over 10 hours) than at PMCH (5–6 hours).

Conclusion: The study revealed a high specimen rejection rate, and prolonged TAT for EDTA samples, with approximately 40% of rejected samples not repeated within 24 hours. These findings provide baseline data to guide future quality improvement initiatives, staff training, and standardization of preanalytical procedures, ultimately enhancing laboratory quality and patient safety. Larger-scale studies are recommended to further investigate the factors contributing to sample rejection and inform corrective measures.

Introduction

The healthcare system is a growing sector [1]. Medical Laboratory generate the most significant portion of structured data in all medical disciplines [2]. Therefore, it is crucial that all laboratory data reported be accurate, precise, and valid to yield reliable results [3]. When selecting performance measures, it is important to consider those with the greatest impact on patient care, areas where improvements are more feasible, and those that are prone to frequent errors [4].

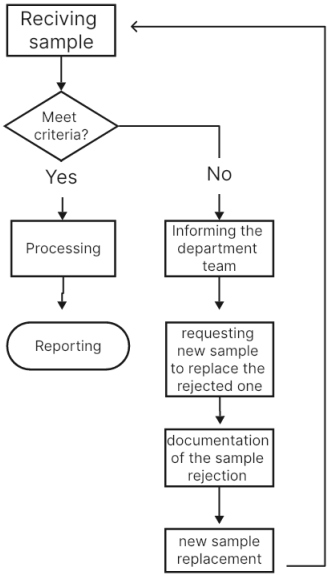
To avoid providing inaccurate results or failed testing, the laboratory should have clear criteria for sample acceptance [5]. Accrediting agencies, such as ISO 15189, require laboratories to implement standardized criteria for sample processing and to enforce a sample rejection system [5, 6]. ISO 15189 accreditation involves standardized procedures for sample collection, handling, and documentation; regular internal audits; staff competency assessments, and validation of analytical methods to ensure reliable results and continuous improvement of laboratory performance [5, 6].

Clinical laboratories worldwide have established protocols for sample collection and analysis, as well as several criteria, to judge the quality of the samples for analysis [7]. Two essential performance measures recommended for clinical laboratories are rejected samples and TAT [8]. Sample rejection has many reasons, which vary between laboratories [9]. Some rejection criteria are common to all laboratories, including: insufficient specimen collection, labeling errors, missing information on the request form, incorrect requests, clotting, inadequate sample volume, improper tubes, hemolysis, and incorrect transportation or storage temperatures [9]. Clotted and hemolyzed samples are the most common causes of sample rejection [9]. These errors are due to inadequate or incorrect knowledge and skills in performing venipuncture, and inadequate training for phlebotomists [10]. Supplementary Table 1 presents the different types of samples and their rejection criteria. Hence, specimen rejection has significant clinical implications for patient care, including the discomfort of re-drawing blood, potential complications such as iatrogenic anemia or hematoma, delay in TAT, and result reporting [11]. Therefore, addressing opportunities in the preanalytical phase is helpful in influencing cost-effectiveness, improving quality, and increasing customer satisfaction [9].

The laboratory technician who receives the sample is responsible for evaluating it according to the established criteria [12]. If a sample is rejected, the laboratory will notify the department where the patient resides. The notification should include the patient's information and reason for rejection. Moreover, this should be recorded clearly, as established by laboratory and hospital policies, which are critical for sample tracing and feedback evaluation [12]. However, the decision to replace the sample or cancel the order should be made by the physician responsible for the patient [12]. (Figure 1) describes the laboratory staff who receive the sample and the process of accepting or rejecting the samples.

TAT indicates the efficiency of the laboratory workflow process [13]. Furthermore, it marks the timeframe for clinicians to plan the management of their patients upon receiving the laboratory results. Hospital Management uses TAT compliance as one of the two yardsticks to evaluate the efficiency of laboratory services [14]. Therefore, this study aimed to evaluate the percentage of rejected samples and TAT in the hematological departments of the two largest Palestinian Governmental Hospitals in the West Bank region. This is the first study in the Palestinian Ministry of Health (PMOH) to systematically assess pre-analytical quality indicators in hematological and routine coagulation testing across two major tertiary governmental hospitals.

Figure 1: Steps of the sample recipient by the laboratory staff and the process of whether accepting or rejecting the samples in hospital laboratories.



Methods

Study Design

This retrospective study was conducted in the Hematology Departments in the laboratories of Palestinian Governmental hospitals. The rejected sample documentation was evaluated, as described in the PMOH regulations. This study was conducted between February 2023 till September 2023. This period was specifically chosen because Hebron Governmental Hospital (HGH) began documenting rejected samples in February 2023. The hospitals' included in this study were the HGH in Hebron, which has 237 beds, provides medical services for more than 700,000 people, and the Palestinian Medical Complex Hospital (PMCH) in Ramallah, which has 312 beds, and provides services for more than one million people. Both hospitals are in the process of being accredited by ISO15189 [6] and follow the same sample acceptance and rejection policies, as established by internal regulations implemented by PMOH.

Data Collection

All data were collected manually from the Avicenna Hospital Information System (HIS) and manual documents. Based on the PMOH criteria for sample rejection, all samples received in the lab and rejected based on the rejection criteria will be documented on the respective form. Some technicians document the rejection reason on HIS, and sometimes will document the rejection on both. This study followed samples rejected in the Hematological department of the hospital laboratories for EDTA samples, which are mainly used for testing Complete Blood Count (CBC), and Na-citrated tubes, which are mainly used for coagulation tests, including Prothrombin Time (PT), and Activated Partial Thromboplastin Time (APTT).

The other parameter evaluated was the TAT. Because the rejected samples will not be reported immediately, and new samples will be requested to be repeated, the value of the TAT will be evaluated for two time points. The sample TAT of the results from the first request time until the final report is referred to as True TAT. The sample TAT, extending from the receipt of the new sample until the final reporting is referred to as Actual TAT.

Data Analysis and Statistics

Results were presented using the mean percentage from each month of rejected samples per month, then the graphs were plotted using the Mean ± Standard Deviation (SD) of the evaluated period. Significant differences between groups were evaluated using the student's independent t-test and *P-value*, in which significance was considered as $P^{*}<0.05$, $P^{**}<0.01$, and $P^{***}<0.001$.

Ethics Approval and Consent

The study protocol was approved by the Birzeit University Scientific Research Committee. Then approved by the Palestinian Ministry of Health, the Medical Laboratories Department (No. 2024-353). All patients' data were anonymized and handled with high confidentiality.

Results

Evaluating the Rejected Samples Percentage and Documentation in the Hematology Departments in HGH and PMCH

The samples were collected from various departments in both hospitals, between February and September in the year 2023. The total number of blood samples received by the hematology departments in the HGH hospital laboratory during the study period (8 months) were 61,254 samples, and at the PMCH hospital laboratory, there were 56,243 samples, as presented in (Supplementary Figure 1A).

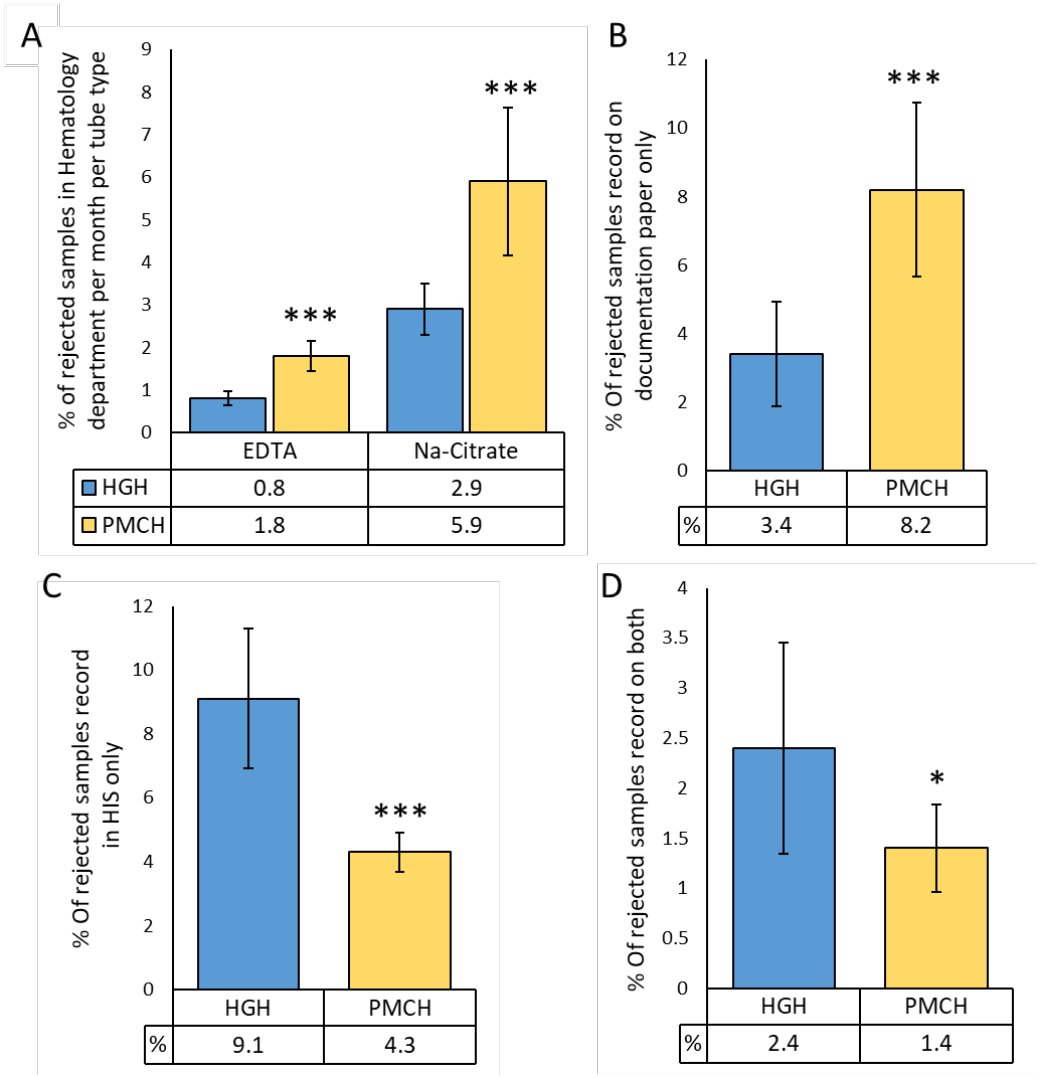
From these samples received in the hematology departments, 640 samples were rejected at the pre-analytical stage and weren't processed in HGH, and 1,157 in PMCH (Supplementary Figure 1B). The percentage of rejected samples in these hospitals was 1% ± 0.18 per month at the HGH, while it was 2.1% ± 0.42 per month at the PMCH (Supplementary Figure 1C). By distributing the samples depending on the tube type of EDTA tubes or Na-Citrated tubes, it was found that the mean percentage of rejected EDTA samples was 1.8% per month at PMCH compared to 0.8% per month at HGH (Figure 2A).

The mean percentage of rejected Na-citrated samples was 5.9% per month at the PMCH, compared to 2.9% per month at the HGH (Figure 2A).

By investigating the distribution of the percentage of the rejected samples by referring to the wards at the hospitals, the highest mean percentage of the EDTA and the Na-citrated tubes was at the PMCH hospital, as presented in (Supplementary Figure 2). The main criteria for sample rejection in both the PMCH and the HGH were Clotted, Insufficient (had less volume than needed), Hemolyzed, Incorrect sample, Overfilled samples, Diluted blood samples with intravenous fluids, and samples collected from patients and received in the laboratory without a request for laboratory testing. At the PMCH and HGH laboratories, the main rejection criteria were the clotted samples in the EDTA tubes, with a percentage of 11.2% and 11.9% per month, respectively, as presented in (Supplementary Figure 3).

Tracking the rejected samples' documentation throughout the study period (Figure 2B, C, D), revealed an inconsistency in the documentation process. Part of the samples were documented properly on the rejected files manually, with a percentage of 8.2% at the PMCH and 3.4% at the HGH (Figure 2B), while rejected samples documented only on the HIS software were of 4.3% at the PMCH and 9.1% at the HGH (Figure 2B). On the other hand, rejected samples were documented by both systems (paper and HIS) in 1.4% and 2.4% of the rejected samples at PMCH and HGH, respectively (Figure 2C).

Figure 2: Evaluating the Rejected Samples Percentage and Documentation in the Hematology departments in HGH and PMCH.

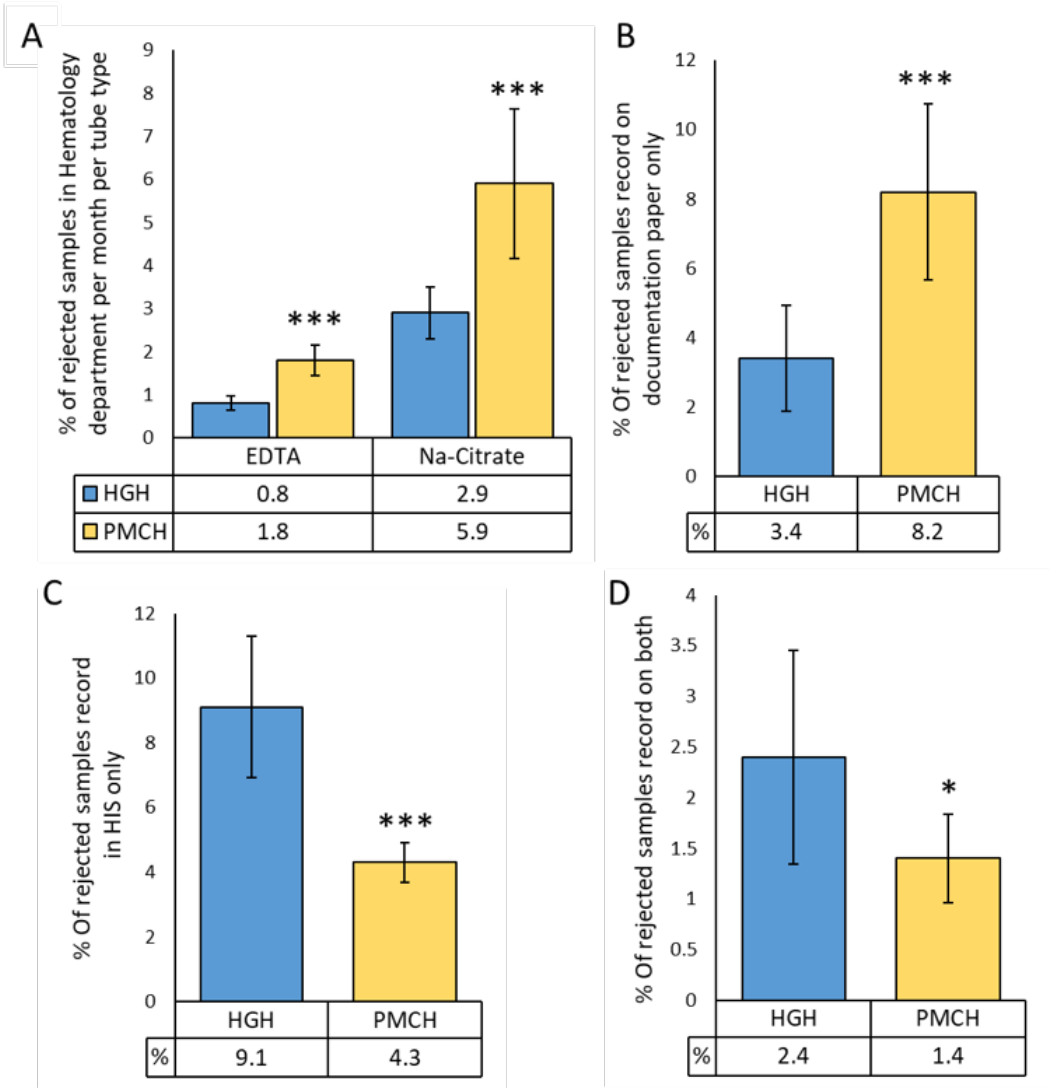


*(A) Comparison of the mean percentage of the total rejected EDTA tubes in the Hematology departments of both hospitals and the comparison of the mean percentage of the rejected Na-Citrated samples in the Hematology departments of both hospitals per month in the period Feb –Sep 2023. (B) Frequency of the rejected samples documentation using the manual paper documentation method in both hospitals, the HGH (blue column) and the PMCH (yellow column). (C) Frequency of the rejected samples documentation on the HIS software in both hospitals. (D) Documentation of the rejected samples on both the paper documents and the HIS software at the same time, in both hospitals. Results are represented as mean±SD per month of the study period. Significant difference was evaluated using independent T. Test, * P < 0.05, *** P < 0.001.*

Evaluating the TAT for the Rejected Samples in PMCH and HGH, Concerning the Critical Values

The average of the TAT for the EDTA tubes or the Na-citrated samples at the PMCH was significantly lower than that at the HGH, where the true TAT were 6 hours and 52 minutes at the PMCH and 10 hours and 38 minutes at the HGH. While for the Na-citrated samples, the average TAT was 5 hours and 1 minute for the PMCH and 10 hours and 59 minutes at the HGH (Figure 3A). On the other hand, the Actual TAT of the EDTA tube samples was 27 minutes at the PMCH and 19 minutes at the HGH, but for the Na-citrated samples, the average TAT was 34 minutes at the PMCH and 41 minutes at the HGH (Figure 3B), the results showed no statistically significant difference. Evaluation of the critical values' TAT is an essential step in evaluating the efficiency of the laboratory. Investigating the values reported for the rejected samples after resending them showed that the percentage of rejected samples reported as critical values was 7.8% in the PMCH for the EDTA tubes and 3.1% for the HGH (Figure 3C). The critical values for the Na-citrated samples were less than those for the EDTA, since for the PMCH it was 0%, but for the HGH it was 0.6%, (Figure 3C). By investigating the time needed to report these critical values, we calculated the true TAT for both hospitals and showed that both were close in these results with almost 6 hours for both of them, while the actual TAT was less at the HGH (15 minutes), compared to the PMCH (1 hour and 37 minutes) (Figure 3D), the results showed no statistically significant difference.

Figure 3: Comparison of the TAT for the rejected samples in PMCH and HGH, concerning the critical values.

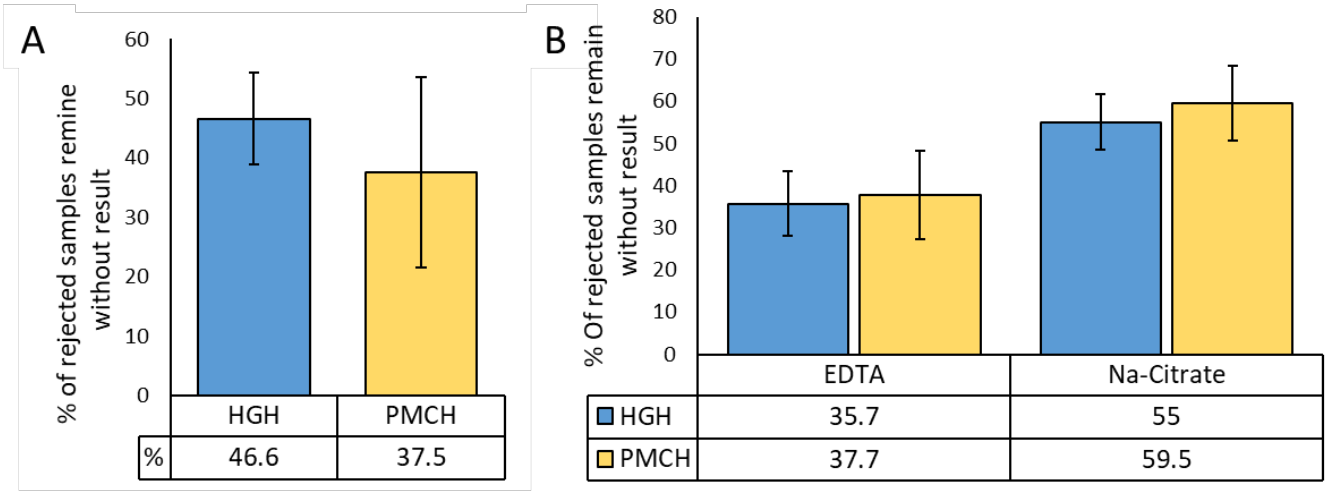


*(A) True TAT average of the rejected samples of the EDTA samples and the Na-Citrated samples in the PMCH and the HGH. The blue columns represent HGH, and the yellow columns represent PMCH. (B) Actual TAT average of the rejected samples of the EDTA samples and the Na-Citrated samples in the PMCH and the HGH. (C) Critical value frequency for the rejected samples upon being repeated, for EDTA and Na-citrated samples in PMCH and HGH. (D) True TAT for critical values reported after repeating the rejected samples by calculating the True and Actual TAT, at the PMCH and HGH. *P < 0.05, **P < 0.01.*

Rejected Samples but not Repeated Within 24 Hours

The most direct consequence of specimen rejection is the need to collect a new specimen for the patient to replace the rejected sample. Recollecting samples from patients is challenging; sometimes patients refuse to give blood samples again, or they have been discharged from the hospital, or even the healthcare person in charge will not collect another sample for any reason. As a result, these patients receive no results for the originally ordered tests. By comparing the hospitals enrolled in the study, the PMCH and the HGH, both had almost similar frequencies for no results for repeated samples. In total, 37.6% of rejected samples remained without results in PMCH, meaning that no second samples were prepared to replace the rejected ones, while this frequency was 46.6% in the HGH (Figure 4A). Further analysis of rejected samples that remain without results revealed that no significant difference was observed for EDTA and Na-citrated samples in both PCMH and HGH (Figure 4B).

Figure 4: Rejected Samples without repeating sampling within 24 hours.



(A) The graph represents the frequency of rejected samples, that have no reported results within 24 hours, the blue columns represent the HGH, and the yellow columns represent the PMCH. (B) Graph represented the frequency of the rejected samples of the EDTA or Na-citrate samples, comparison between the PMCH and HGH.

Discussion

Quality control (QC) monitors the total testing process to consider and identify laboratory errors, which ensures accurate and reliable results and increases confidence in laboratory performance [15]. Institutions that adopt patient safety measures, and implement corrective interventions, can make healthcare safer for patients and healthcare workers. This can happen by identifying the factors and events contribute to medical errors. Developing multifaceted prevention protocols and implementing these strategies at various healthcare levels [16].

Recently, research highlighted that one of the most important QC measures in medical laboratories is the rejection of samples. These lead to delays in sample analysis and prevent clinicians from providing timely management to their patients, which negatively impacts patients' outcomes [17]. In our study, we chose the PMCH in Ramallah, and the HGH in Hebron. Rejected samples' records in the hematology laboratory were evaluated from different perspectives to understand the main sources of errors, as well as to understand the possible correction measures that should be taken. This study revealed a significant number of rejected samples, which are likely to result in delays in diagnosing and treating patients.

The results were compared to other countries; a recent comprehensive meta-analysis study reported an average percentage of blood sample rejection of 1.99% [9]. Another study from Malaysia reported a high sample rejection rate of 3.38% in the hematology department [17]. While recent reports from Saudi Arabia showed a sample rejection rate of 1.3% in the hematology department [18]. Correspondingly, the rejected sample rate in the Palestinian MOH-related hospitals is considered similar to the average percentages reported in other countries. This reflects the increased quality of follow-ups of the system. Alternatively, this decrease in rate can be explained by the lack of documentation of the samples, which may need more evaluation and follow-up within the same hospitals and an audit from the MOH. By investigating specific tests based on EDTA tube, the rejection rate for this sample was 0.8% at HGH and 1.8% at PMCH, which are significantly lower compared to studies from Lahore, and Sri Lanka, where the rejection rates were 5.15% and 3.3%, respectively [19, 20]. Additionally, Na–citrated samples exhibited the highest percentage of rejection rate in the Hematology department of the investigated Palestinian hospitals. Indeed, coagulation samples are sensitive due to the need for a precise anticoagulant-to-blood ratio, and timely processing to prevent clotting or degradation [21]. Several factors contribute to the variation in rejection rates, such as type and duration of the study, sample size, rejection criteria between hospitals, laboratory personnel awareness, and samples received from different wards [12, 22].

By looking at the most common reason to reject the samples, clotted samples is the highest reason in both hospitals, which reflects a possible lack of knowledge of the phlebotomists, according to the instructions provided by the tubes' manufacturer [23]. Similar findings have been reported in various studies worldwide, including those conducted in China, Korea, India, and Malaysia, which report that the improper mixing of the sample was the reason for blood clotting after sample collection [12, 20, 24, 25]. Insufficient samples or under-filling of tubes is the second reason for sample rejection in both HGH and PMCH in the Hematology department, consistent with the findings from the mentioned countries [12, 20, 24, 25]. In contrast, a study done at Chughtai Lab, Lahore [19], found that labeling errors and storage errors were

considered the most significant reasons for rejection, followed by diluted samples [19]. The higher frequency of insufficient samples refers to the difficulty in collecting sufficient blood samples from newborns, children, and ICU patients [9, 17]. Although hemolyzed samples, though not recorded in rejected EDTA samples at HGH, remain a significant portion of all rejected samples. To address this, hospitals should implement internal training for phlebotomy staff [12]. Errors in test ordering, where samples are received without a physician's request, also contribute to rejections. Improved communication and cooperation between medical teams need to be addressed [12]. At HGH, the Na-Citrate tube had more "no order" cases compared to EDTA samples, likely due to unfamiliar test ordering. The occurrence of 'no order' cases is linked to inadequate inspection of sample collection forms and a shortage of personnel relative to patient demand for laboratory services [12].

Considering the complexity of the healthcare system, documentation of records is an essential component of communication [26]. The documentation can be paper-based, electronic, or both. Organizations are required to establish a clear system to track and follow patient information [27]. On the other hand, organizations should have the ability to follow up and meet the respective standards [28]. Rejected samples criteria at the PMOH hospitals are requested to be documented using the paper system and per the respective Standard Operating Procedures (SOP). By following up on the MOH-related hospitals' records, it was obvious that there is no consistency in the documentation, which indicated miscommunication between the laboratory employees and the documentation system established by the hospital based MOH guidelines. There was rejection data documented using the paper documents, or the HIS, or both. This inconsistent documentation decreases the confidence and reliability of the whole documentation and recording of the rejection sample, as well as for any other documents that include mistakes [3]. These mistakes and loss of credibility jeopardize patient safety and the ability to follow up, which affects medical decision-making [3]. However, reporting this inconsistency, it gives the possibility that part of the rejected samples was not reported at all. This should be evaluated in future evaluations of the rejection system by following up on the rejection system daily and spontaneously. From our perspective, the documentation systems and hospital policies can be updated and improved to reflect the hospital's needs [13].

Sample rejection prevents sample analysis, which increases TAT and causes delays in patient diagnosis and treatment [9]. The rejection of samples impedes the analysis process and necessitates new sample requests [14]. Moreover, timely reporting of trustworthy results, especially critical values save the patient's life, and supports effective clinical decisions [29]. By evaluating the TAT in the PMCH and HGH, the results of the critical values were taking a very long time to be reported since the first request time, which we referred to as the True TAT, but it was obvious that the action to replace the samples at the PMCH was more efficient than in the HGH, that was taking almost twice the time needed to be reported in PMCH. The percentage of critical values in the EDTA rejected samples criteria was significantly higher at the PMCH, which may need more attention and orientation for the medical staff responsible for sample collection. In our study, the explanation for the long true TAT may be due to the greater complexity of very large hospitals, which could contribute to less effective communication among healthcare staff members [30].

A significant consequence of laboratory sample rejection is the state of "no results" available for the rejected samples. Explanations for this include discharge of the patients before repeated sample collection, or inappropriate communication between the health work team. At the governmental hospitals, laboratory testing costs are reimbursed through governmental insurance in some cases or by the patients themselves; these costs are supported by the MOH, so the payments are not considered high. Even though some patients may refuse repetitive payments. Also, patients' rights are to refuse the recollection of blood samples, which may jeopardize the patient's safety and privacy; it is much better to get the sample properly the first time [31]. On the other hand, "no results" of these requests highlight the probability of system abuse. Questioning the reality of the actual need for blood collection from the beginning. There is a probability of wasting time for blood collection and wasting time for laboratory analysis, additionally, exposing the system to consuming unnecessary and expensive resources [15].

This study has several limitations; it was conducted only in two laboratories in governmental hospitals, and only in the hematology department. The research was done for the first time in the Palestinian health system. The quality recording system in the laboratories of the PMOH was implemented a few months before this study was performed, and the new regulations were determined to be present by laboratory technicians. However, it is retrospective and depends on the accuracy of documented records; differences in technician experience and adherence to sample collection procedures may have influenced rejection rates. The study aimed to document the present situation for corrective action measures to be implemented in the future.

Conclusion

Although this study was conducted in two Palestinian governmental hospitals, its findings have impact on laboratories worldwide. Pre-analytical errors are mostly preventable. As our findings showed, the main reason for sample rejection was insufficient communication between the healthcare team and inadequate training. The high TAT for the rejected samples is considered dangerous, especially when critical samples are reported for these samples. So, documentation of the rejected samples monthly, in addition to organizing periodic training for new healthcare personnel, will enhance the reliability of

laboratory test samples and results, which prevents TAT delays and consequently improves patients' outcomes. Advanced training programs for laboratory employees and information about the methods of recording should be clear enough for laboratory technicians. Policies and regulations can be modified as needed through the laboratory employees' experience and practice. Finally, modern technology usage, for keeping documents, will be useful for tracing and highlighting errors and mistakes, which will provide fast and efficient intervention for correction, as well as a high level of analysis to provide evaluation of the system quality.

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Declaration of competing interest
The authors declare no conflict of interest.

Data Availability
All study data are included in the article and/or supporting information.

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Ethics approval statement
The study protocol was approved by the Birzeit University Scientific Research Committee. The Palestinian Ministry of Health, Medical Laboratories Department (No. 2024-353).

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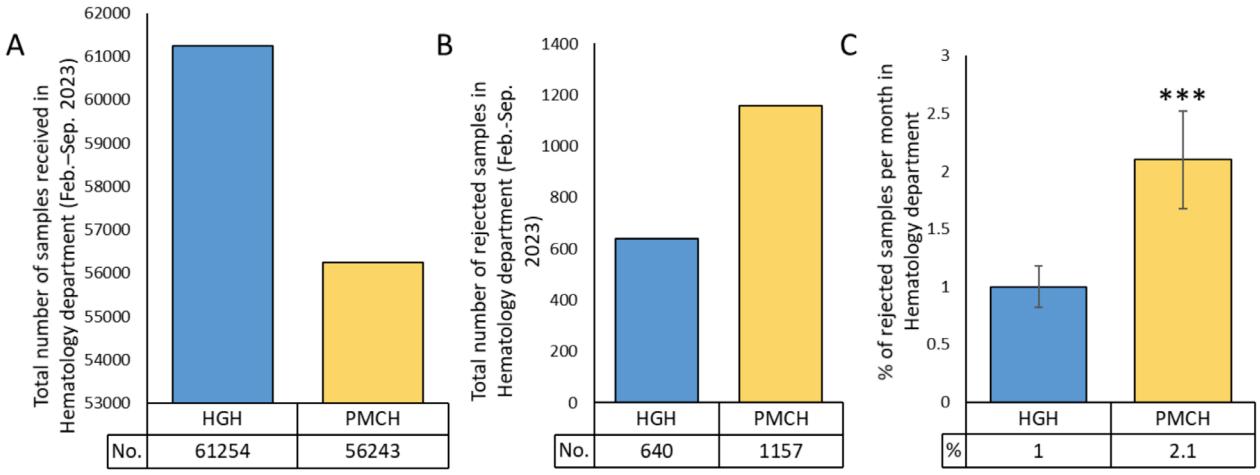
Supplementary files

Supplementary Table 1: Rejected samples criteria in the clinical laboratory department.

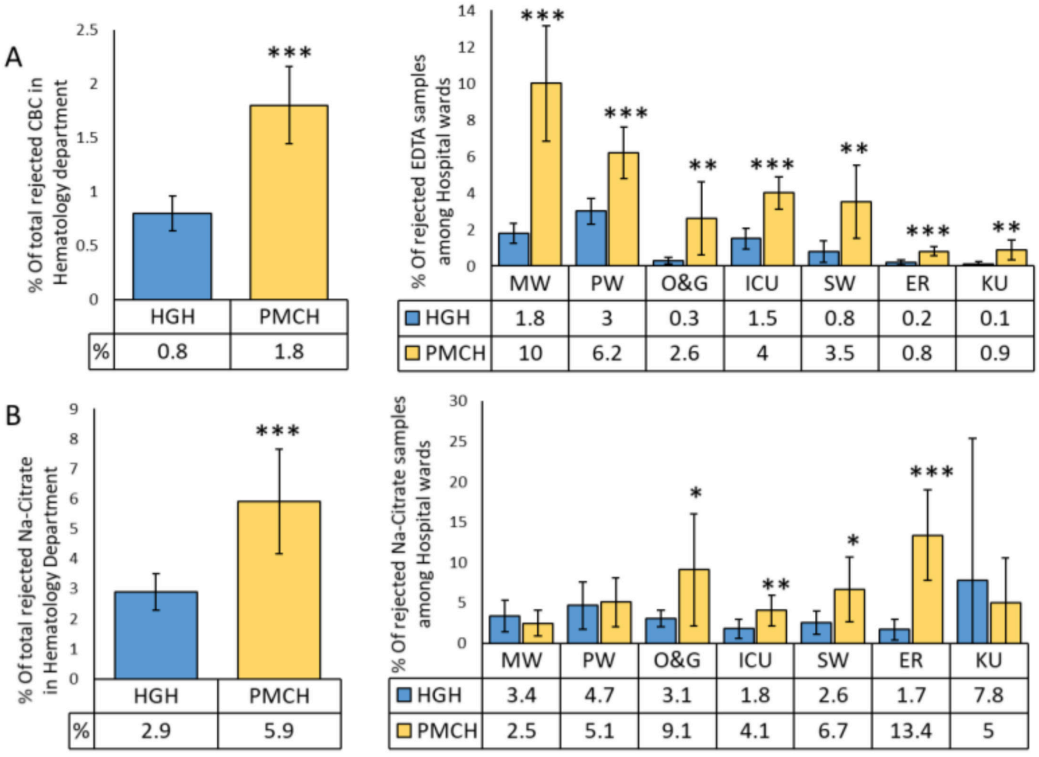
Clinical Laboratory section	Sample Type	Rejection criteria	The most common causes of rejection	Consequences of the problem
Hematology (Lavender top)	EDTA	Clotted sample	1. Inappropriate mixing of the tubes. 2. Lack of phlebotomy training [1].	1. Pseudo-thrombocytopenia. 2. False leukopenia, aberrant red cell indices. 3. Instrument downtime due to probe clogging [2].
		Insufficient samples	1. Incorrect phlebotomy techniques. 2. Difficult venous access [1].	1. Erroneous laboratory results due to improper anticoagulant-to-blood ratio. 2. Redraws [2].
		Excessive amount	1. Clot due to insufficient anticoagulant [2].	1. Erroneous laboratory results [2].
		Labeling errors	1. Missing data. 2. The specimen container labeling away from the specimen collection site [2].	1. Incorrect or delayed diagnosis. 2. Incorrect Treatment [3].
		Lipemic samples	1. Non-fasting patient. 2. Pre-existing metabolic disorders [4].	1. Interference of fat with the optical reading of an instrument leads to incorrect result reporting [4].
		Hemolysis samples	1. Use of inappropriate needle 2. Prolonged tourniquet application 3. Evacuation of the syringe into a tube [1].	1. Interference with spectrophotometric assays [5].
		Contaminated sample	1. Collection by intravenous catheters [6]. 2. Incorrect tube order during phlebotomy. 3. Contamination with alcohol [7].	1. Falsely Pancytopenia [2].
Coagulation (Blue top)	Citrated	Clotted sample	1. Overfilling causes insufficient anticoagulants. 2. Inappropriate mixing of samples [8].	1. Erroneous laboratory results [2].
		Labelling Error	1. Missing data. 2. Label the specimen container away from the specimen collection site [2].	1. Incorrect or delayed diagnosis. 2. Incorrect Treatment [3].
		Overfilled Tube	1. Clot due to insufficient anticoagulant. 2. Direct free flow dripping of blood into the tube in pediatric [8].	1. Erroneous Coagulation test results [9].
		Collected Via an indwelling catheter	1. Improper Anticoagulant-to-blood ratio [10].	1. Erroneous laboratory results [10].
		Hemolysis sample	1. Rough handling of the samples. 2. Vigorous shaking 3. Prolonged centrifugation. 4. Use of inappropriate needle size. 5. Prolong tourniquet application 6. Evacuation of the syringe into a tube [2].	1. Significant analytical interference [5].

Supplementary Figure 1: Comparison of the distribution of the rejected samples in the Hematology.



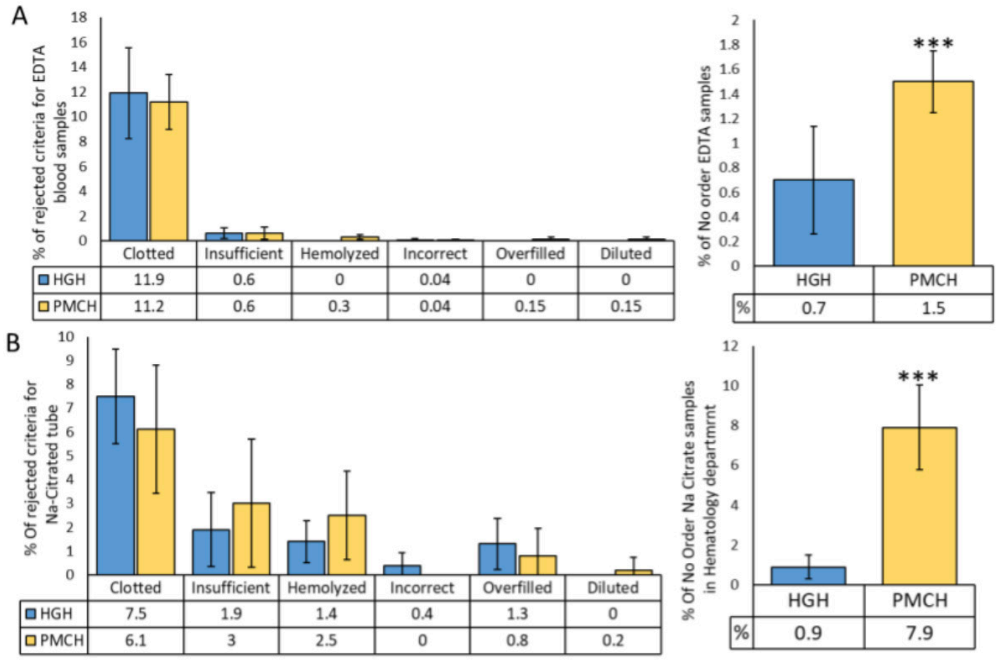
*(A) Total number of samples received at the Laboratory's Hematology department at the Hebron Governmental Hospital (HGH) and the Palestine Medical Complex Hospital (PMCH) during the study period. The blue column represents the HGH, while the yellow column represents the PMCH. (B) Total number of rejected samples in both hospitals during the study period. (C) The mean percentage of the rejected samples in both hospitals per month. Results are represented as mean (of the monthly percentage) ± SD during the months of the study period. Significant difference was evaluated using an independent t-test, *** P < 0.001.*

Supplementary Figure 2: Frequency of the EDTA and the Na-citrated blood rejected samples, referred to the requesting department in HGH and the PMCH hospitals, from February to September 2023.



*(A) The percentage of rejected EDTA samples in the hematology departments, by referring to the percentage distribution of these samples to the blood test requesting word at the hospitals. HGH are presented by blue columns and the PMCH are presented by yellow columns (B) The percentage of the rejected Na-Citrate samples in the hematology departments, by referring to the percentage distribution of these samples to the blood test requesting word at the hospitals, throughout the study. The analyzed departments included the Medical Ward (MW), Pediatric Ward (PW), Obstetrics and Gynecology (O&G), Intensive Care Unit (ICU), Surgical Ward (SW), Emergency Department (ED), and Kidney Unit (KU). Results are represented as mean ± SD per month of the study period. Significant difference was evaluated using independent T. Test, *P < 0.05, **P < 0.01, ***P < 0.001.*

Supplementary Figure 3: Rejection criteria distribution for EDTA and Na-Citrated blood samples in HGH and PMCH.



*(A) (Left Panel) Graph displays the frequency of each rejection criterion for EDTA samples across the PMCH and the HGH departments, within the study period. (Right Panel) Graph presenting the percentage of the EDTA samples received to the HGH and the PMCH laboratories with no order per month. (B) (Left Panel) The graph presents the frequency of each rejection criterion for Na-Citrated samples across the HGH and the PMCH laboratories. The blue columns represent the HGH, while the yellow columns represent the PMCH. The rejection criteria include clotted samples, insufficient samples, hemolysis, incorrect labeling, overfilled samples, and diluted samples. Results are represented as mean ± SD per the months of the study period. Significant difference was evaluated using an independent T. Test, *** $P < 0.001$.*

Supplementary References

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