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Enhancing Quality Assurance in Haematology Laboratory Sample Collection: Strategies for Identifying Sources of Rejection and Mitigation – A Mini Review

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Abstract
The haematology laboratory at Hospital Universiti Sains Malaysia implements sample acceptance and rejection according to the rejection criteria following guidelines by ISO 15189. This study aims to evaluate causes and types of samples rejection and we also introduce an initiative to reduce sample rejection. A 2-month retrospective study was conducted by obtaining and evaluating data from samples sent to the haematology laboratory from June and July 2022. The laboratory received a total of 32,726 samples, out of which 1,084 (3.31%) were rejected. Rejection rates were 3.19% and 3.43% consecutively for June and July 2022. The leading cause of sample rejection was clotted samples (36.6%), followed by duplicate requests (22.9%), and insufficient amounts (16.9%). High sample rejection rates were recorded from the paediatric surgical ward, medical high-dependency unit, and otorhinolaryngology ward. The lowest rejection rate was from the outpatient clinic. The overall sample rejection rate was 3%. Therefore, a few mitigation strategies need to be employed to improve the acceptance rate.

Keywords
Haematology Laboratory, Preanalytical Phase, Quality Indicator, Specimen Rejection

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Introduction

Hospital Universiti Sains Malaysia is a teaching hospital that consists of an 800-bed capacity. Primary patient management includes both inpatient and outpatient care. Haematology laboratory, which has been accredited with MS ISO 15189, provides an essential service to the hospital by offering various routine and special tests. The routine haematology services are complete blood count, peripheral blood film, erythrocyte sedimentation rate, and coagulation tests. Meanwhile, the specialized haematology tests include specialized coagulation tests, haemoglobin analysis, immunophenotyping, and molecular study. The laboratory receives blood samples 24 hours a day, every day. Therefore, a proper sample collection is mandatory for optimum patient results and care.

The majority of the haematological tests require blood samples collected in either *Ethylenediaminetetraacetic acid (*EDTA) or sodium citrate tubes. These containers contain calcium chelators to prevent blood clot formation. The use of a heparin tube is not recommended because it may induce platelet and leukocyte clumping leading to erroneous results. Sample rejection is a component of the quality indicators in laboratory accreditation. The laboratory specialist in charge should outline the criteria for sample rejection with input from the treating physicians. The clinician must comply with these rejection criteria to improve the quality of patient care by obtaining accurate and reliable results. This study aims to identify the source of rejection samples, propose multiple mitigation strategies, and offer an illustrative guide for the accurate collection and identification of haematology laboratory samples.

Materials and Methods

This audit was carried out in the Haematology laboratory, at Hospital Universiti Sains Malaysia from June 2022 until July 2022. Sample rejection data were obtained from the Laboratory Information System (LIS). The rejection criteria are as outlined in the Laboratory Reference Manual according to MS ISO 15189 accreditation. The following inclusion rejection criteria were applied: (1) incomplete request which includes indication, diagnosis, and treatment, (2) duplicate request in LIS, (3) wrong test request, (4) clotted sample, (5) insufficient/ excess sample, (6) aged sample, (7) lysed Sample, (8) inappropriate container, (9) unsatisfactory specimen received i.e. spillages, leaking or breakages, (10) no prior appointment for special tests, (11) office hour test sent after office hour, (12) handwritten labelling and (13) labelling error (discrepancy form and bottle). The results were analysed using Microsoft Excel (Microsoft Corporation, Redmond, WA) and the Statistical Package for the Social Sciences (SPSS) Statistics for Windows (Version 25.0; Armonk, NY, IBM Corp.). The type of request and the causes of rejection were determined and analysed accordingly.

Results

During this study period, a total of 32,726 samples were received by the haematology laboratory, and out of that 1,084 samples were rejected (Table 1). The rejection rate for June was 3.19% and it increased to 3.43% in July.

Table 1: Specimen received and rejected

	Total sample received	Rejection, n (%)
June 2022	16.460	526 (3.19)
July 2022	16,266	558 (3.43)
Sum	32,726	1,084 (3.31)

Clotted samples were the commonest cause of rejection (36.6%) followed by duplicate requests (22.9%) and insufficient samples (16.9%) (Table 2).

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Table 2: Reason for specimen rejection

Cause of rejection	N	%
Aged Sample	73	6.73
Clotted Sample	397	36.6
Duplicate request in LIS	248	22.9
Excess Sample (exceed anticoagulant ratio)	43	3.97
Handwritten labelling	2	0.18
Incomplete request form	70	6.46
Insufficient sample	183	16.9
Unsatisfactory specimen	3	0.28
Lysed Sample	3	0.28
No prior appointment for special tests	6	0.55
Office hour test sent after office hour	23	2.12
Inappropriate container	16	1.48
Labelling errors (form and bottle discrepancy)	1	0.09
Wrong test request	16	1.46
Total	**1084**	**100%**

From Table 3, the highest rejections were seen from the paediatric surgical ward (7.07%), medical high dependency unit (6.65%), and ENT ward (6.36%) leading to inevitably delayed patient management and care. While the least rejection was from the outpatient clinic (1.50%).

Table 3: Site of specimen collection

Ward	Rejected	Received	Reject (%)
A&E	132	3168	4.17
Clinic	58	3865	1.50
Daycare	15	477	3.14
ENT ward	7	110	**6.36**
Gynaecology ward	18	611	2.95
Haematology Oncology ward	34	1843	1.84
ICU	29	1789	1.62
Labor room	41	1527	2.69
Medical High Dependency Unit	63	947	**6.65**
Medical Ward	207	5008	4.13
Mix surgical and medical ward	33	715	4.62
Neonatal ICU	94	2233	4.21
Neonatal ward	16	292	5.48
Neurology ICU	17	964	1.76
Obstetric ward	34	624	5.45
Ophthalmology ward	6	296	2.03
Orthopaedic ward	76	1509	5.04
Other wards	0	1042	0.00
Paediatric surgical ward	20	283	**7.07**
Paediatric ward	44	1178	3.74
Private ward	27	892	3.03
Psychiatry Ward	1	17	5.88
Surgical High Dependency Unit	25	1434	1.74
Surgical ward	87	1902	4.57

Discussion

The total testing process begins with a preanalytical phase, a point at which the physician orders a particular laboratory test. This is followed by the analytical phase and post-analytical phase i.e. after which the laboratory result is ready for interpretation. Approximately 70% of the total testing errors occur during the preanalytical phase.[1] This phase includes (but is not limited to) the preparation of patients, specimen

collection, transportation, and storage. Errors that occur during this process are human-dependent and thus highly preventable through continuous laboratory education. Examination of samples before their acceptance is a gatekeeping process to eliminate a potential erroneous result due to any errors that occur during preanalytical steps. Although it may look simple, sample rejection may add a significant burden to the patients, attending physicians as well as laboratory personnel.

There are several impacts of sample rejection, especially on patients. Patients may have to undergo unnecessary repeat blood takings, causing inconvenience and discomfort, along with the possibility of excessive iatrogenic blood loss that might necessitate a blood transfusion.[2] Additionally, it can result in a prolonged hospital stay. A study conducted found a lag in the availability of test results of about 108 minutes.[3] Furthermore, there may be exorbitant hospital charges. The impact on general management may lead to a delay in diagnosis. Similarly, sample rejection affects laboratory personnel as it is time-consuming and increases their workload. Therefore, specimen rejection can significantly affect patients, their clinical management, and the laboratory.

The delay in turnaround time may have a significant impact on clinical tests ordered with a stat testing priority potentially postponing the availability of critical values thus delaying the decision-making and the initiation or cessation of treatment. Similar delays may also impact routine and other non-urgent tests. From a laboratory perspective, specimen rejection may cause additional expenses to the total testing process and increase the workload for the laboratory staff. One model described that the consequences of rejected specimens cost $357.15 for each hospital inpatient and $337.05 for each hospital outpatient per year, altogether comprising between 0.23% and 1.2% of total hospital operating costs.[4] Another study reported the total expenditure of specimen rejection that led to sample recollection and reanalysis was about USD 43,210.[3]

Following the 5th edition of the Malaysian Society for Quality in Health, based on service standard 15 for pathology services, the rejection requirement must be less than 1% monthly. [5,6] However, a study conducted in Haematology Unit in Universiti Teknologi MARA, revealed a rejection rate of 3.38%, while from Advanced Medical and Dental Institute (AMDI) it was 0.9%, respectively. [6,7] While our rejection rate was higher compared to the standards set by MSQH. This was most probably due to new staff i.e. house officer's intake, inexperienced phlebotomist, improper blood-taking techniques, and poor sample management. The clotted sample was our predominant cause of rejection and a similar incidence was also reported in a study conducted at an Oncology Institute Universiti Sains Malaysia.[7] The clotted samples are unsuitable for many haematological testing. It interferes with the accurate measurement of blood cells resulting in falsely decreased blood counts. The clotted sample also consumes fibrinogen and many coagulation factors; thus, invalidating the haemostasis tests. In addition, the presence of micro or small clots can block the aspiration tubing in the haematology analyser causing machine malfunction and consequently adding to more unscheduled maintenance.

This is the most challenging preanalytical factor in a haematology laboratory because the platelet (primary haemostasis) is invariably activated following venepuncture (endothelial injury) leading to clot formation. The major causes of clotted samples are (i) inadequate or inappropriate mixing of anticoagulation using EDTA or sodium citrate bottle, (ii) difficult blood collection, and (iii) incorrect order of draw. The first runner-up was sample adequacy which can be either inadequate or excess blood samples. Low sample volume can draw out water from blood cells resulting in the shrivelling of red blood cells (echinocytes) due to the hypertonicity of the EDTA anticoagulant. As a result, the Mean Cell Volume (MCV) will be falsely reported as low and the Mean Corpuscular Haemoglobin Concentration (MCHC) is erroneously elevated. [8] On the other hand, overfilled tubes are at risk of clot formation due to the incorrect blood-to-anticoagulant ratio. Sample rejection was contributed mainly from inpatients with the highest number reported from the paediatric surgical ward. The lowest rate of specimen rejection was from the outpatient clinic. This may be since the venepuncture procedure at the outpatient clinic was usually done by experienced staff nurses and the patients were generally well. Therefore, the blood collection procedure was smoother and easier. In addition, it is located very near to the laboratory and hence there is no delay in the sample transportation. On the other hand, collecting blood samples from paediatric patients was more demanding because they could wrestle the procedure and their veins were generally less visible.

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Figure 1 provides an illustrative guide for the correct collection and identification of samples in the haematology laboratory. It outlines the process upon receiving a specimen, wherein rejection criteria are assessed by a reviewer. If the criteria are not met, the sample's importance determines whether it will be discarded; precious clinical samples are notified while satisfactory samples undergo acceptance procedures outlined in the accompanying flowchart.

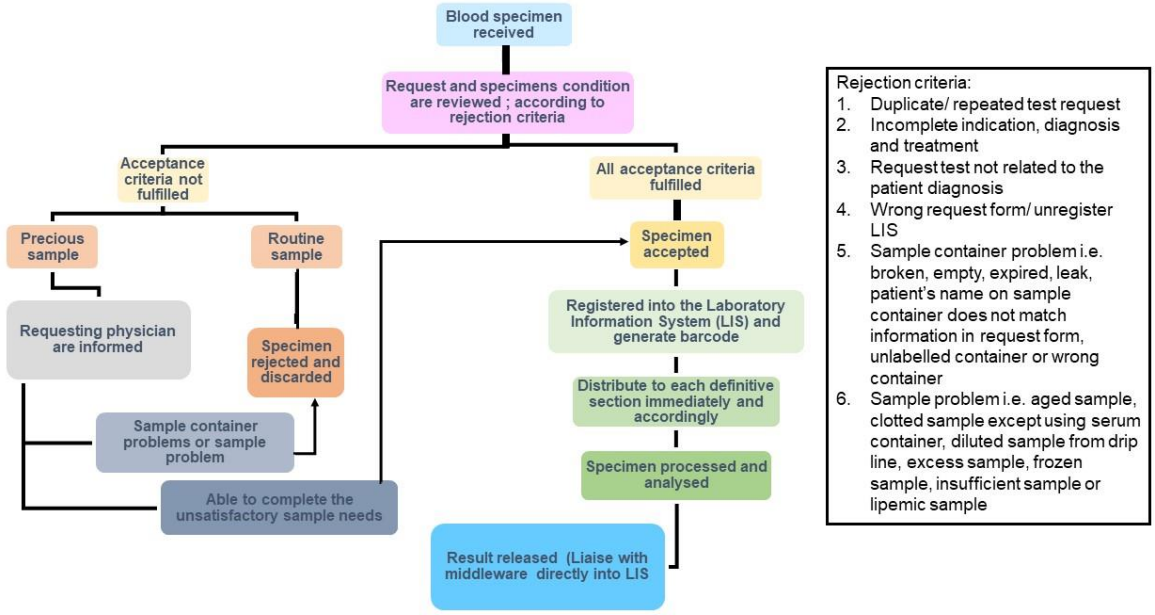

Figure 1: Proposed visual aid depicting the appropriate procedures for collecting and identifying specimens in a haematology laboratory.

The strategies aimed at reducing rejection rates involve enhancing the blood collection process through various measures. This includes ensuring proper training of phlebotomists with strict adherence to sample collection standard operating procedures. Additionally, it begins with monitoring specimen ordering to ensure accurate patient identification. Other enhancements encompass improvements in patient communication and safety, meticulous patient preparation, precise timing of collections, and the utilization of well-equipped phlebotomy equipment. Vein scanners are utilized to identify small veins, especially in paediatric cases, oncology patients, or those with end-stage renal failure. Proper collection techniques are applied, along with guaranteeing precise specimen labelling and timely transportation to the laboratory by implementing pneumatic transport systems to reduce sample transportation time. Immediate processing upon arrival is ensured. Moreover, laboratory automation is enhanced through the integration of information systems, computerized order entry, and automated phlebotomy tray preparation, including the adoption of barcodes to streamline specimen routing and monitoring. Effective communication between laboratory personnel and physicians is also emphasized to minimize errors.

Conclusion

In summary, routine assessment of sample rejection is crucial for identifying prevalent mistakes and devising plans for remedial actions to ensure precise and dependable laboratory outcomes. While the overall rejection rate of 3% falls within acceptable bounds, this investigation emphasizes the necessity of continuous quality enhancement endeavours in the laboratory environment. By tackling the recognized causes of rejection and introducing pre-emptive measures to alleviate them, every hospital can bolster the dependability and efficiency of its haematology services, leading to improved patient outcomes and contentment.

Conflict of Interest

The authors disclose no potential conflicts of interest

References

1. Plebani M, Sciacovelli L, Aita A, Pelloso M, Chiozza ML. Performance criteria and quality indicators for the pre-analytical phase [published correction appears in Clin Chem Lab Med. 2015 Sep 1;53(10):1653]. Clin Chem Lab Med. 2015;53(6):943-948. doi:10.1515/cclm-2014-1124
2. Karcher DS, Lehman CM. Clinical consequences of specimen rejection: a College of American Pathologists Q-Probes analysis of 78 clinical laboratories. Archives of Pathology & Laboratory Medicine. 2014; 138 (8):1003-8. https://doi.org/10.5858/arpa.2013-0331-CP
3. Cao L, Chen M, Phipps RA, et al. Causes and impact of specimen rejection in a clinical chemistry laboratory. Clinica Chimica Acta. 2016; 458:154-8. https://doi.org/10.1016/j.cca.2016.05.003
4. Green SF. The cost of poor blood specimen quality and errors in preanalytical processes. Clinical Biochemistry. 2013; 46 (13-14):1175-9. https://doi.org/10.1016/j.clinbiochem.2013.06.001
5. Performance Indicator Malaysian Society for Quality in Health Hospital Accreditation Standards. 5th Edition ed.: Malaysian Society for Quality in Health; 2017. p.227 https://www.msqh.com.my
6. Kamal F, Wan Mohd Saman WA, Adbul Monir M. Analysis of Sample Rejection and the Impact on Quality of Care in Patients in a Single Tertiary Healthcare Facility in Malaysia. Environment-Behaviour Proceedings Journal. 2020; 5(13):175-81. https://doi.org/10.21834/e-bpj.v5i13.2104
7. Noordin SS, Isa S. Evaluation of Blood Sample Rejection in a Clinical Laboratory of an Oncology Institute. Malaysian Journal of Medicine and Health Sciences. 2021; 49–54.
8. Christopher MN. Collection and Handling of Blood. In: Dacie and Lewis Practical Haematology (12th edition): Elsevier, 2017: 5-6