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Original Article

Preanalytical Error Sources: Pediatric Laboratory Experience

Esra Fırat Oğuz, Fatma Karaca Kara, Murat Kızılgün

Abstract

Objective: Accurate laboratory results are important in disease detection, classification, treatment, and follow-up. In this study, we aimed to evaluate records within a year for samples rejected in a biochemistry laboratory.

Methods: Data of rejected samples in Ankara Children's Health and Diseases, Hematology Oncology Training and Research Hospital biochemistry laboratory between January 2015 and December 2015 were retrospectively screened from the laboratory information system. Errors were evaluated according to their type and working groups.

Results: A total of 565,409 samples were sent to the biochemistry laboratory over one year. In total, 408,374 samples were sent to the central laboratory and 157,035 of them were sent to the emergency laboratory. Further, 3,309 (0.81%) samples sent to the central laboratory were rejected because of the detection of preanalytical errors, while 1,097 (0.69%) samples sent to the emergency laboratory were rejected. The more common sources of error were clotted samples and inappropriate sample volumes. Besides, more common errors were observed in hemogram and blood gas study groups.

Conclusion: It is extremely important to keep the error-prone preanalytical phase that affects the quality of the results of a laboratory under control to obtain accurate and qualified results. Error proofing should be planned by taking into account the characteristics of the samples sent to the laboratory.

Keywords: laboratory, preanalytical error, clotted sample

Introduction

Laboratory results are known to be effective in approximately 70% of medical decisions (1). For this reason, accurate laboratory results are important in processes such as diagnosis of the disease, its classification, treatment, and follow-up. The total testing process includes all the steps from the clinician's decision to request the test to the reporting of the laboratory result to be used in a decision. In recent years, these stages have been examined in five different categories. The phase in which the test is requested and performed is called the pre-preanalytical phase, the phase beginning from the test request to the analysis of the sample is called the preanalytical phase, the phase from the control of the laboratory results to the approval is called the post-analytical phase, and the phase from the evaluation of the results to its use in the decision is called the post post-analytical phase (2, 3). Errors can occur at any of these stages in the medical laboratory. Although the main goal in the development of laboratory medicine is to reduce analytical errors, it has been shown that approximately 62% of all errors occur in the preanalytical stage (4-6).

Sample volume and preanalytical variables affect the quality of laboratory tests. When the pediatric population is considered, the age of the patient and especially the sampling stages have an important place among the preanalytical variables (7-9). In children, phlebotomy is technically very difficult and requires special skills, training, and experience (7). One consequence of the difficult bloodletting process is that hemolytic, clotted, and especially low-volume blood samples are obtained. An inadequate volume taken in the anticoagulated tubes can cause erroneous results due to sample dilution. Especially in newborns, hemolytic samples cause interference in the measurement of bilirubin (7, 10, 11). Regarding children, it is also troublesome to collect urine samples, which are often used in laboratories.

In this study, we aim to examine and analyze the records of samples rejected in our hospital biochemistry laboratory between January 2015 and December 2015 and to evaluate the errors related to laboratory testing processes.

This study was presented as a poster at the Turkish Biochemistry Association Preanalytic Stage Symposium, 19-20 May 2016, Adana, Türkiye.

Biochemistry Laboratory, Ankara Child Health and Diseases Hematology Oncology Training and Research Hospital, Ankara, Türkiye

Address for Correspondence:
Esra Fırat Oğuz
E-mail: dr_esrafirat@hotmail.com

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Methods

In this study, the tests that came to the Center and Emergency Biochemistry laboratories of Ankara Pediatrics Hematology and Oncology Training and Research Hospital between January 1 and December 31, 2015 were evaluated. The data obtained from the laboratory information system (LIS) for the samples rejected within a year were retrospectively scanned (patient consent was not received because a retrospective data scan was performed). The approval for the study was received from the Board of Clinical Researches of Ankara Pediatrics Hematology and Oncology Training and Research Hospital (No: 2016-039).

The central laboratory consists of six study groups including hemogram, coagulation, routine biochemistry, hormone, blood gas, and urine. The emergency laboratory consists of five study groups including hemogram, coagulation, emergency biochemistry, blood gas, and urine.

Patients whose laboratory tests are requested by the clinician during working hours are directed to the blood collection counter. Sample tubes barcoded here are given to the patients to be transferred to the blood collection room, and phlebotomy is performed by the blood-taking nurses. Samples are delivered to the laboratory from the blood collection room at certain hours of the day.

Samples taken from patients in the departments are delivered to the laboratory by the staff in charge of each department.

In emergency cases, samples taken by the nurses are delivered by the staff in charge of the emergency laboratory.

Samples deemed inappropriate are rejected at the stage of blood acceptance by entering the reason in the LIS. After the samples are received and accepted, they are classified according to the working groups and given to the technicians in charge. At this stage, the samples requiring centrifugation are centrifuged and analyzed.

After the reason for preanalytical errors detected prior to the analysis stage is entered in the LIS, and the clinic or the patient's doctor is informed, the sample is rejected and a new sample is requested. The samples that were evaluated incorrectly in the analytical phase are reanalyzed.

The rejected samples were categorized and analyzed according to specific error sources, and the error frequency was specified (clotted samples, inappropriate sample volume, erroneous barcoding, inappropriate type of sample, hemolyzed sample, lipemic sample, others).

Statistical analysis

Sample numbers, error numbers, and percentages are specified for each study group. In the study, the percentages of the data obtained from error numbers were calculated using Microsoft Office Excel.

Results

Within one year, a total of 565,409 samples were accepted: 408,374 in the central laboratory and 157,035 in the emergency laboratory. Of the samples accepted by the central laboratory, 3309 were rejected at the sample acceptance stage due to a preanalytical error or were rejected by the in-charge technicians at or before the working phase. The preanalytical error rate of the central laboratory was found to be 0.81% (Table 1). Of the samples accepted by emergency laboratories, 1097 were rejected in the preanalytical phase, and the preanalytical error rate of the emergency laboratory was found to be 0.69% (Table 2).

When the distribution of the errors according to study groups was examined, it was determined that the most common preanalytical error in the central laboratory was in the hemogram (52.92%) study group and in the blood gas (68.29%) study group in the emergency laboratory. The least common preanalytical error was observed in the urine study groups of both laboratories (2.24% for the central laboratory and 5.01% for the emergency laboratory).

Table 1. Distribution of central laboratory error types and study groups

	Study groups							
Error types	Routine biochemistry	Hemogram	Hormone	Urine	Coagulation	Blood gas	Total	The distribution of Errors (%)
Clotted sample	-	1591	-	-	348	498	2437	73.64
Inappropriate sample volume	105	90	249	51	84	88	667	20.16
Incorrect barcoding	17	38	13	7	5	1	81	2.45
Inappropriate sample type	12	22	-	12	10	2	58	1.75
Hemolyzed sample	4	-	-	-	1	-	5	0.15
Lipemic sample	1	2	-	-	1	-	4	0.12
Others	34	8	8	4	3	-	57	1.73
Total errors	173	1751	270	74	452	589	3309	
Total samples	114003	114615	66339	89849	18413	5155	408374	
Percentage of error[a] (%)	0.15	1.53	0.41	0.08	2.45	11.43	0.81	
Percentage of error[b] (%)	5.23	52.92	8.16	2.24	13.66	17.79		

[a]: within the working group; [b]: within the total error

Table 2. Distribution of emergency laboratory error types and study groups

	Study groups						
Error types	Emergency biochemistry	Hemogram	Urine	Coagulation	Blood gas	Total	The distribution of Errors (%)
Clotted sample	-	100	-	66	653	819	74.66
Inappropriate sample volume	60	43	46	5	85	239	21.79
Incorrect barcoding	3	2	-	-	1	6	0.55
Inappropriate sample type	2	4	4	-	5	15	1.37
Others	5	2	5	1	5	18	1.63
Total errors	70	151	55	72	749	1097	
Total samples	46065	42709	24314	345	43602	157035	
Percentage of error[a] (%)	0.15	0.35	0.23	20.87	1.72	0.69	
Percentage of error[b] (%)	6.38	13.76	5.01	6.56	68.29		

[a]: within the working group; [b]: within the total error

When the errors of the central and emergency laboratories were examined by category, the clotted samples (73.64% for the central laboratory, 74.66% for emergency laboratories) and inappropriate sample volume (20.16% for the central laboratory and 21.79% for emergency laboratories) were found to be the most frequent sources of error.

When the groups with the highest error percentages in the study groups were evaluated, it was observed that 11.43% of the samples in the blood gas study group were rejected by the central laboratory and 20.87% of the samples were rejected by the emergency laboratory due to a preanalytical error.

Discussion

Preanalytical errors are those that occur in the process from the test request to sample analysis and have the largest share of errors during the total test procedure (5).

In this study, the preanalytical errors of the pediatric laboratory were evaluated retrospectively and the error frequency was determined. In the literature, there are studies in which a frequency of preanalytical errors between 0.2% and 0.77% has been found (6, 12, 13). Similar to these studies, the error rate of the central laboratory has been found to be 0.81%, and the error rate of the emergency laboratory has been found to be 0.69%. The total error percentage has been found as 0.78%. The difference in the percentage of errors is thought to be the expected result of the difference between laboratories and users. It is also an expected situation that, in relation to the patient population, a higher preanalytical error is observed in the pediatric laboratories in which our study was performed.

The most frequent causes of preanalytical errors were shown to be hemolyzed samples, inadequate sample volumes, and clotted samples in the study of Lippi et al. (14). Hemolyzed samples, inadequate samples, and incorrect sample taking were shown as the first three causes in the study of Plebani et al. (15). In the study of Özcan et al. (13), in which they evaluated data from biochemistry and microbiology laboratories, clotted samples and taking samples incorrectly were determined as the most frequent causes. In the study of Küme et al. (16), in which emergency laboratory errors were evaluated, it was found that the most common errors were samples that were not requested, clotted samples, and empty sample tubes. In our study, it was observed that the two most frequent causes of error were clotted samples and inadequate sample volumes. This is thought to be due to the difficulty of taking blood in children.

When samples were evaluated according to study groups of preanalytical errors, it was observed that the most frequent error rate was in the hemogram study group in the central laboratory and in the blood gas study group in the emergency laboratory. The fact that the lowest error rate was in the urine study group in both laboratories is thought to be because the urine samples are easier to obtain than blood samples. Previous studies have indicated that errors are common in coagulation, blood gas, and sedimentation study groups where sample levels are important (13, 16). It is thought that the diversity may be related to the problems encountered in different patient populations (adult, child).

When the study groups were evaluated within themselves, it was observed that 11.43% of the blood gas samples admitted to the central biochemistry laboratory and 20.87% of the coagulation samples admitted to the emergency laboratory were erroneous. Inappropriateness of sample levels, especially in coagulation samples, is more prominent when it comes to pediatric patients, from whom samples are obtained in small volumes. Similarly, small sample volumes in blood gas samples and inability to provide optimum conditions during both the sampling process and transportation to the laboratory are thought to play a role in increasing the error rate.

Analysis and reporting of inappropriate and poor quality samples leads to errors in medical decisions (1). For this reason, in terms of accurate and timely production of results, it is important to identify, correct, and prevent errors in each step of the total test process.

Conclusion

In order to produce accurate and high-quality results, it is extremely important to control the preanalytical errors that most often affect the quality of the results produced by the laboratory. The characteristics of the patient population served by the laboratory should also be considered and the necessary planning should be undertaken to prevent errors.

Ethics Committee Approval: Ethics committee approval was received for this study from Ankara Pediatric Hemotology Oncology Training and Research Hospital Clinical Studies Committee (No: 2016-039).

Informed Consent: Written informed consent was not received due to the retrospective nature of this study.

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