Journal of Pharmacy and Pharmacology 4 (2016) 318-321
doi: 10.17265/2328-2150/2016.07.005

# Preanalytic Error Rates for the Central Laboratory of a Large-scale Public Hospital in Turkey

Kemal Türker ULUTAS[1], Metin CELIK[2], Beril AKCIMEN[3], Esin Damla Z. KARACOR[3] and Fatma KARAZİNDİYANOĞLU[2]

*1. Antakya State Hospital, Department of Medical Biochemistry, Antakya, 31000, Hatay, TURKEY*

*2. Osmaniye State Hospitals, Central Clinical Laboratory, Osmaniye, 80000, Osmaniye, TURKEY*

*3. Kadirli State Hospital, Central Biochemistry Laboratory, Kadirli, 80750, Hatay, TURKEY*

**Abstract:** The pre and post analytical phase in a testing cycle contributes up to 93% of total laboratory errors. However, pre-analytical phase is primarily responsible for errors. Hence, it is of precise importance for the laboratory to study error occurrence rates during the testing cycle and implement a quality improvement plan to release an accurate result. The present study was conducted during the period Jan-Nov 2014 in the Central Clinical Lab in Osmaniye State Hospital, Turkey. During period of 11 months, 626897 samples were monitored for major preanalytical problems at the receiving counter of the Central Clinical Laboratory. Among all preanalytic laboratory errors, 35.4% of the errors were associated with clotted sample, 25.5% errors with inadequate sample, and 25.3% errors with hemolysed sample in the laboratory. Assessment considering the departments showed that emergency unit had the highest error rates (hemolysis: 52.5%, lipemic: 42.9%, damaged: 34.6%, clotted: 34.2%, inadequate: 26.8%, wrong material: 17.6%, wrong barcode: 16.7%). There was significant difference among the departments in terms of preanalytic errors ($p < 0.001$). Based on these observations, major preanalytic errors are of great concern and needs corrective approach via proper educational programs to related personals. If this area is ignored, that can lead to negative patient outcome. However, a better specimen quality and patient satisfaction are achieved with the high quality personal-based education regarding pre-analytical errors.

**Key words:** Pre-analytical errors, biochemistry laboratory, hemolysis.

## 1. Introduction

Central clinical laboratories play a central role in patient care and diagnosis. Though there is lot of automation in biochemistry, hematology and clinical microbiology labs, still there are many variables which can influence the lab results [1]. Correct reporting requires that all the phases as pre-analytical, analytical and post–analytical should be free from errors [2]. Earlier, it was required that main emphasis on quality be made in analytical phase, but it is equally important that it be recognized in all phases [3, 4]. It has been estimated that up to 62% errors happen during pre-analytical phases [5]. In another study, 93% errors occurred during pre-analytical and post–analytical phases combined [6].

The reason for doing a retrospective study was to find out preanalytical variables and sources of errors occurring in our laboratory according to the departments. The aim was to survey preanalytical procedures to find sources of error and their relative frequencies in the central clinical laboratory of the hospital, associated with patient satisfaction, so that corrective actions could be taken.

## 2. Material and Methods

Current study was a retrospective one and it was carried out in Central Clinical Laboratory of Osmaniye State Hospital; a 400 bedded hospital located south region of Turkey. Duration of study was 11 months, from Jan 2014 to Nov 2014. All samples received during this period in clinical biochemistry lab were

**Corresponding author:** Kemal Türker ULUTAS, M.D, Antakya State Hospital, Department of Medical Biochemistry, Antakya, 31000, Hatay, TURKEY.

included. Sample collection for patients was centralized for different sections of central laboratory, like hematology, biochemistry and microbiology units. Total samples received in central lab were 626897. Samples were collected using vacuum collection tubes. Following categories of pre-analytical data were available for study period: hemolysed sample, clotted sample, misidentification (incorrectly labeled vials or incorrectly filled barcodes), inadequate sample (wrong choice of vial), damaged sample, incorrect sample, and lipemic sample. Data for time delay was not available.

The frequencies and crosstabs procedure were used to create two way and multiway tables. Statistics were used for describing variables and tables. After tabulation p values were determined using persons' chi-squares. P value of less than 0.05 was considered significant. All the statistical methods were carried out through the SPSS Statistic program for windows version (Version 15.0).

## 3. Results

Out of total 626897 samples received from patients, pre-analytical errors, according to above mentioned criteria, were found in 1566 samples (0.24%). Distribution with percentage has been given in table-1 below. The most common mistakes among the errors were clotted sample (555 cases: 35.4%). Second most common cause was inadequate sample (399 cases, 25.5%). In other preanalytic errors, 396 (25.3%) of were associated errors with hemolysed sample in the laboratory, 104 (6.6%) errors with damaged sample, 74 (4,7%) errors with incorrect sample, 24 (1.5%) errors with misidentification, and 14 (0.9%) errors with lipemic sample.

Considering the departments, emergency unit had the highest error rates (hemolysis: 52.5%, lipemic: 42.9%, damaged: 34.6%, clotted: 34.2%, inadequate: 26.8%, wrong material: 17.6%, wrong barcode: 16.7%). Maternity service, intensive care, internal medicine, child psychiatry and newborn intensive care were the departments with high preanalytic error rates after emergency unit. There was a significant difference among the departments in terms of preanalytic errors ($p < 0.001$). All data with percent were given by table-2 below. We could not ascertain other causes of pre-analytical errors due to paucity of data, especially time lag between sample collection and actual analytic process.

## 4. Discussion

Majority of times, preanalytical errors usually do not cause bodily harm to the patients, apart from repeat sampling, delay in reporting, but in many cases, it may have serious consequences or may result in completely wrong treatment for the patient [7-9]. As laboratories are going for various accreditations, there is requirement of reducing errors in all phases of laboratory functioning. Keeping track of pre-analytical data errors may lead to significant decrease in errors occurring during later processes. Preparation of pre-analytical quality manual may help in reducing these errors [10, 11]. In the current study, pre-analytical error rates were evaluated and compared among the departments of our hospital. Nurses and paramedical staff usually collect samples, many of whom did not recognize/ were not aware of the importance of collection of samples by correct techniques. This may also be caused by rotational duties, excessive workload and variety of workload. In our view, these may be the main reasons behind emerging pre-analytical errors.

Among the pre-analytical errors, clotted samples are one of major causes. Although these samples are easy

**Table 1 Total and daily preanalytic errors observed in clinical chemistry laboratory according to percent.**

| Preanalytic Errors | N (total) | (%) | n/day |
|---|---|---|---|
| Clotted Sample | 555 | 35,4 | 1,68 |
| Inadequate Sample | 399 | 25,5 | 1,21 |
| Hemolysed Sample | 396 | 25,3 | 1,2 |
| Damaged Sample | 104 | 6,6 | 0,32 |
| Incorrect Sample | 74 | 4,7 | 0,22 |
| Misidentification | 24 | 1,5 | 0,07 |
| Lipemic Sample | 14 | 0,9 | 0,04 |

**Table 2 Preanalytic errors with their percent according to the departments of Osmaniye State Hospital.**

| Departments | Clotted | Damaged | Hemolysis | Inadequate | Lipemic | Misident. | Incorrect S. |
|---|---|---|---|---|---|---|---|
| Emergency | 190 (34,2%) | 36 (34,6%) | 208 (52,5%) | 107 (26,8%) | 6 (42,9%) | 4 (16,7%) | 13 (17,6%) |
| Maternity Service | 59 (10,6%) | 2 (1,9%) | 17 (4,3%) | 31 (7,8%) | 0 (0%) | 2 (8,3%) | 2 (2,7%) |
| Intensive Care | 53 (9,5%) | 6 (5,8%) | 60 (15,2%) | 27 (6,8%) | 1 (7,1%) | 5 (20,8%) | 5 (6,8%) |
| Internal medicine | 41 (7,4%) | 21 (20,2%) | 15 (3,8%) | 33 (8,3%) | 2 (14,3%) | 3 (12,5%) | 27 (36,5%) |
| Child Psychiatry | 36 (6,5%) | 3 (2,9%) | 5 (1,3%) | 71 (17,8%) | 0 (0%) | 1 (4,2%) | 9 (12,2%) |
| Newborn IC | 36 (6,5%) | 0 (0%) | 4 (1,0%) | 21 (5,3%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Infant Service | 26 (4,7%) | 1 (1,0%) | 3 (0,8%) | 26 (6,5%) | 1 (7,1%) | 0 (0%) | 2 (2,7%) |
| Orthopedics | 19 (3,4%) | 2 (1,9%) | 4 (1,0%) | 11 (2,8%) | 2 (14,3%) | 0 (0%) | 0 (0%) |
| Children Service | 15 (2,7%) | 6 (5,8%) | 0 (0%) | 13 (3,3%) | 1 (7,1%) | 0 (0%) | 0 (0%) |
| Infectious Disease | 12(2,2%) | 4 (3,8%) | 1 (0,3%) | 6 (1,5%) | 0 (0%) | 0 (0%) | 4 (5,4%) |
| Cardiology | 7 (1,3%) | 4 (3,8%) | 21 (5,3%) | 5 (1,3%) | 1 (7,1%) | 0 (0%) | 2 (2,7%) |
| Pediatric Surgery | 7 (1,3%) | 0 (0%) | 0 (0%) | 2 (0,5%) | 0 (0%) | 1 (4,2%) | 1 (1,4%) |
| Urology | 7 (1,3%) | 2 (1,9%) | 9 (2,3%) | 7 (1,8%) | 0 (0%) | 0 (0%) | 1 (1,4%) |
| Dermatology | 6 (1,1%) | 0 (0%) | 3 (0,8%) | 2 (0,5%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Nephrology | 6 (1,1%) | 2 (1,9%) | 8 (2,0%) | 0 (0%) | 0 (0%) | 1 (4,2%) | 0 (0%) |
| Endocrinology | 5 (0,9%) | 0 (0%) | 0 (0%) | 1 (0,3%) | 0 (0%) | 1 (4,2%) | 1 (1,4%) |
| General Surgery | 5 (0,9%) | 3 (2,9%) | 3 (0,8%) | 6 (1,5%) | 0 (0%) | 1 (4,2%) | 1 (1,4%) |
| Head&Neck Surg. | 5 (0,9%) | 0 (0%) | 1 (0,3%) | 6 (1,5%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Gastroenterology | 4 (0,7%) | 4 (3,8%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Chest Diseases | 3 (0,5%) | 2 (1,9%) | 7 (1,8%) | 5 (1,3%) | 0 (0%) | 0 (0%) | 1 (1,4%) |
| Neurology | 3 (0,5%) | 0 (0%) | 2 (0,5%) | 5 (1,3%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Coronary IC | 2 (0,4%) | 0 (0%) | 15 (3,8%) | 2 (0,5%) | 0 (0%) | 1 (4,2%) | 1 (1,4%) |
| Vascular Surgery | 2 (0,4%) | 1 (1,0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Thoracic Surgery | 2 (0,4%) | 2 (1,9%) | 1 (0,3%) | 1 (0,3%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Brain Surgery | 1 (0,2%) | 2 (1,9%) | 4 (1,0%) | 4 (1,0%) | 0 (0%) | 0 (0%) | 3 (4,1%) |
| Home Care | 1 (0,2%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Ophthalmic Surg. | 1 (0,2%) | 0 (0%) | 1 (0,3%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Physiotherapy | 1 (0,2%) | 0 (0%) | 1 (0,3%) | 5 (1,3%) | 0 (0%) | 2 (8,3%) | 0 (0%) |
| Dialysis | 0 (0%) | 0 0%) | 1 (0,3%) | 0 (0%) | 0 (0%) | 2 (8,3%) | 1 (1,4%) |
| Plastic Surgery | 0 (0%) | 0 (0%) | 2 (0,5%) | 2 (0,5%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Psychiatry | 0 (0%) | 1 (1,0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0(0%) |

to detect, clots at the micro level are difficult to detect by eye assessing [1, 8]. It is well-known that the most common reason for clotting is improper mixing of samples just after collection, which may have been the case in our hospitals and labs [5]. In some labs, inadequate quality control during in house preparation of EDTA vials may be one of the reasons. Additionally, wrong sampling from serum supplied vessels may cause same error [12]. In our study showed that emergency and maternity units had high error rates and needed a corrective approach via proper sampling education to related personals.

Inadequate samples are usually problems for paediatrics and related intensive care unit patients [13]. Additionally, nursing staff sometimes fail to recognize the importance of using veins in which IV lines have not been introduced [14]. Considering the departments unit-by-unit, emergency unit had the highest rates for inadequate samples with 26.8%. However, combining error rates of pediatrics and related units resulted as 33.2%, and returned this rank that pediatrics moved to first rank consistent with the literature.

In the literature, prevalence of haemolysed samples has been reported in up to 3.3% of routine samples [6]. Daily hemolysed sample rate was observed as 1.2% in our study. We know that haemolyzed samples are

slightly difficult to detect in haematology labs as compared to biochemistry labs, as samples are usually not centrifuged in the former. This may result in falsely lower number of preanalytical errors caused by haemolysis in haematology labs like ours, as compared to those seen in other studies done in biochemistry labs [9].

Akin et al., reported that most of the errors by clinic laboratories were generated by preanalytic phase [14]. In our study, pre–analytical errors were found in 0.24% of total samples in center laboratory, which were well than those seen in other studies. Emergency unit had the highest error rates [11]. We compared the results of our study with those of two national studies by Kume et al. [5], performed in clinical chemistry laboratory at the medical faculty hospital of Izmir city, and Tuncer et al. [12], performed in central laboratory in Bursa city, which showed that most of their results were comparable with those of our study.

As a first approach, we organized an education series on preanalytical errors for all the doctors and paramedical staff of our state hospital. In this, we discussed various preanalytical variables and their consequences, including insufficient attention on identification of sample, incorrect practices for receiving blood, and necessity of using paediatric blood collecting vials. It was quite informative to all the staff on reducing the current preanalytic errors of our central laboratory.

## 5. Conclusion

By better communication with clinical staff at all levels, training to staff, preparing and adhering to pre-analytical quality manuals, preanalytical errors can be reduced. The better practices for the laboratory staff are the result of quality improvement initiatives undertaken. This would result in a define level of competence among sample collecting and laboratory staff. If we can focus on reducing errors of emergency unit first, which had the highest error rates, regression of errors in emergency will most likely encourage all staffs of other units of hospital. Additionally, standardization, training and collaboration between laboratory and wards can support to reduce all preanalytical error sources.

## References


[1] Baron, J. M., Mermel, C. H., Lewandrowski, K. B., and Dighe, A. S. 2012. "Detection of Preanalytic Laboratory Testing Errors Using a Statistically Guided Protocol." *American Journal of Clinical Pathology* 138 (3): 406-13.

[2] Howanitz, P. J. 2005. "Errors in Laboratory Medicine: Practical Lessons to Improve Patient Safety." *Archives of Pathology & Laboratory Medicine* 129 (10): 1252-61.

[3] Nichols, J. H. 2011. "Blood Glucose Testing in the Hospital: Error Sources and Risk Management." *Journal of Diabetes Science and Technology* 5 (1): 173-7.

[4] Serafin, M. D. 2006. "Pre-analytic Process Control: Projecting a Quality Image." *Clinical Leadership & Management Review : The Journal of CLMA* 20 (5): E4.

[5] Akasha, R., Mohammed, A., Syed, P. A., Sirageldin, E., Mohammed, E., and Allah, M. G. 2015. "Assessment of Acute Myocardial Infarction by the Use of Special Biochemical Markers." *Ulutas. Med. J.* 1 (3): 68-73

[6] Boone, D. J. 1993. "Governmental Perspectives on Evaluating Laboratory Performance." *Clinical Chemistry* 39 (7): 1461-5.

[7] Cembrowski, G. S., Engebretson, M. J., Hackney, J. R., and Carey, R. N. 1993. "A Systems Approach to Assure Optimal Proficiency Testing in the Hematology Laboratory." *Clinics in Laboratory Medicine* 13 (4): 973-85.

[8] Rossi, E. D., and Schmitt, F. 2013. "Pre-analytic Steps for Molecular Testing on Thyroid Fine-Needle Aspirations: The Goal of Good Results." *CytoJournal* 10: 24.

[9] Wang, S., and Ho, V. 2004. "Corrections of Clinical Chemistry Test Results in a Laboratory Information System." *Archives of Pathology & Laboratory Medicine* 128 (8): 890-2.

[10] Dietzen, D. J. 2012. "Sharpening the CALIPER: Defining Pre-analytic and Biologic Variability in Children." *Clinical Biochemistry* 45 (15): 1131.

[11] Erbil, M. 2007. "Liderlik ve Laboratuvar Yönetimi." *Türk Biyokimya Dergisi* 32 (3): 145-7.

[12] Jagadish, C. Das. 2015. "Hypernatremic Dehydration in Newborn Infants: A Review." *Ulutas. Med. J.* 1 (2): 22-5.

[13] Garon, J. E. 2004. "Patient Safety and the Preanalytic Phase of Testing." Clinical Leadership & Management Review : The Journal of CLMA 18 (6): 322-7.

[14] Akın, K. 2009. "Laboratuvar Güvenliğinde Hasta Tanımlama Hatalarını Azaltmak ve Süreç Kontrolü." Kalite, Akred*itasyon ve Hasta Güvenliği Dergisi* 3 (1): 3-8.