Case Report

Preanalytical variables: Influence on laboratory results and patient care

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Abstract

Pre analytical errors have a major impact on diagnostic accuracy of laboratory results. There have been tremendous work and established quality control criteria for analytical phase of testing but there is paucity of standards for pre analytical phase. Recommendations for sample collection, storage, processing and transport have been developed by national and international consensus. There is a dire need for all laboratories to formulate their own quality manual so that day to day pre analytical errors are curtailed. As the errors in pre analytical phase are not inevitable and should be avoided with diligent application of quality control, education dedicated to patient care. We illustrate the ability of laboratory data by case studies to reinforce the importance of vigilance in pre analytical phase of testing.

Keywords: Laboratory errors, preanalytical phase, quality manual

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INTRODUCTION

Laboratory services play a pivotal part of clinical decision-making process. There have been radical changes that have occurred in the organization, type of tests and the role of medical laboratories. The advances in instrument technology, computer science, and automation have no doubt simplified laboratory diagnostics and reduced analytical error rate.[1] Effective laboratory service is the amalgamation of precision, accuracy, and promptness. The attention of laboratory professionals should now be focused on preanalytical phase which is much more vulnerable to uncertainties and accidents, which can substantially influence patient care.[2] The preanalytical phase is an important component of laboratory medicine.[3] It includes the time from the order of test by the clinician until the sample is ready for analysis - it can account up to 70% of errors during the total diagnostic process.[4]

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Preanalytical errors are largely due to human errors, and they are preventable as they involve mostly human handling in comparison to analytical and postanalytical phase.[5,6] The preanalytical errors include two types of variables. Patient related such as exercise, stress, age, sex, positional effects, and menstruation. Sample related variables such as hemolysis, sample collection technique, transport, and storage. It is, therefore, important that interpretation of laboratory data in physically active individuals should be done with caution taking into account individual lifestyle and biological variation.

Preanalytical variables

Patients

Any error in identification of patient cannot sustain any defense for erroneous laboratory report. These errors occur due to deviation from patient identification procedures. Nowadays, two identifiers of patient-name and unique

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identification number, sometimes, a wristband and occasionally other relative/attendant in case of the comatose patient are used for identification. The use of unlabeled or incorrectly labeled tube for sample collection is prone to error. The vials should bear the patient name, unique ID, age, sex, date of collection, and time of collection.

Sample collection method

It is mandatory to follow the order of draw as it can lead to wrong test result due to contamination with additive from previous blood collection tube. Proper venipuncture technique, maintaining aseptic conditions, allowing drying of antiseptic before skin prick, avoidance of prolonged application of tourniquet, repeated clenching of fist and vigorous shaking of tubes can reduce error rate. The interference of hemolysis with certain assays such as serum potassium assay and aspartate aminotransferase (AST) are well established. There are studies which demonstrated lower incidence of preanalytical error rate. The interference of hemolysis with certain assays such as potassium and AST are well documented. There are studies which demonstrated lower incidence of preanalytical errors when laboratory personnel collect blood samples in comparison to nursing or other personnel.[7] Specimen should be transported in proper manner after collection to maintain its quality. Timely separation of plasma/serum with 24 h of collection, protection from light and appropriate storage and transport of specimens at recommended temperature are measures that improve laboratory results.

Personnel

There are several persons involved in preanalytical phase. The Patient, the clinician (ordering the test), nursing staff, phlebotomist, ward boy (sample transport), medical technician (processing), and laboratory doctor (authentication and release of the report) should understand the impetus of preanalytical phase and its impact on examination results.

Way ahead

We all are aware that it is not possible to eliminate medical errors in totality especially those that are not involving analytical phase. The prudent approach is to follow good laboratory practices and compliance with the new accreditation standards which encompass appropriate steps to prevent laboratory errors. They require multidisciplinary approach involving all stakeholders dedicated to patient care. Quick, effective communication between all healthcare providers is key element in reduction of human errors.

The checklist prepared by College Of American Pathologists for laboratory inspection and accreditation address specimen-related preanalytical variables.[8] The National Committee for Clinical Laboratory Standard in the USA update their guidelines on various aspects of preanalytical variables.[9] Each laboratory should have a quality manual addressing preanalytical variables and device measures to recognize and control these crucial components of laboratory quality. Issues such as minimum sample volume needed for test, patient preparation, posture, duration of tourniquet application time, time of blood collection (to minimize the effect of diurnal variation), processing guidelines, transport and storage conditions should be delineated.[10] Ultimately, it is the quality manual that becomes the compendia for all recognized preanalytical variables and acts as a bible in troubleshooting erroneous results.

The under mentioned cases present glaring examples of preanalytical errors at laboratory.

CASE REPORTS

Case 1

A 25-year-old man was hospitalized with complaints of fever for 7 days. After the admission serum potassium was found to be 5.7 m mol/L, all other laboratory test was normal. During his stay in hospital, the value of potassium fluctuated between 5.5 m mol/to 5.9 mmol/L. Such variations were not expected clinically as discussed with the clinician. The sample collection was done by a senior laboratory phlebotomist in the presence of laboratory doctor. Serum potassium measured from the sample was 4.5 m mol/L (within normal biological reference range). The root cause analysis was done for such variation and it was found that while blood collection in ward by nursing staff there was prolonged application of tourniquet for 2 min with repeated fist clenching by the patient which caused contraction of forearm muscles resulting in release of intracellular potassium due to reduction in intracellular negativity during the depolarization of muscle cells ultimately causing spurious potassium elevation in the analyzed sample.[3,11]

Case 2

A 34-year-old male patient with hepatitis A was admitted to the hospital, on day 2 there was an unexplained deviation in alkaline phosphatase 5 U/L and potassium 17 mmol/L. The results were markedly deviated from previous day results with alkaline phosphatase 432 U/L and potassium 4.2 mmol/L. The reports were not released, and sample was checked which surprisingly was an ethylenediaminetetraacetic acid (EDTA) sample. On investigation, it was found that the plasma was obtained

from blood collected in tripotassium EDTA tube. EDTA chelate magnesium and zinc required for the activity of alkaline phosphatase resulting in markedly low alkaline phosphatase. Potassium EDTA was responsible for such an absurd un reportable potassium level. Immediate, timely intervention and vigilance always prevent disastrous false results.

Case 3

A 46-year-old female indoor patient showed an unexplained diurnal variation in hemoglobin value from 11.1 g/dl to 13.2 g/dl. There was no clinical history of blood transfusion or hemoconcentration. A repeat sample was ordered, and hemoglobin on repeat sample came out to be 11.2 g/dl. To find the cause of such variation we did a work up and found that there was the difference in blood groups between two samples of same patient suggesting that the error was due to inappropriate or mislabeled vacutainer. As the sample collection in indoor patient is done in wards spread all over the hospital and nursing staff works in shifts it becomes evident that regular training of new staff should be undertaken as a continuous process. Training, retraining, and competency assessment are principle values of good quality control. The habit of using prelabeled collection tubes should be abandoned and regular advisory should be sent to phlebotomist and nursing staff involved in sample collection.

Case 4

In yet another case of a 53-year-old man with low hemoglobin values was intercepted by pathologist, a fresh sample taken and correct value reported. The fall of hemoglobin from 10.5 g/dl to 7.3 gh/dl without any bleeding or blood loss alerted the laboratory doctor, and re-sampling was ordered. On subsequent work up, it was found that the sample collection was done from arm where intravenous infusion was given causing hemodilution of analyte.

Case 5

A 56-year-male with chronic kidney disease from an outside hospital came to a laboratory for 24 h urine protein estimation. On testing, the 24 h urine protein estimation came out to be 22,000 mg/dl. A higher 24 h urine value was expected but such higher value raised suspicion of the test result. A repeat test was done, and the value remains unaltered. On close examination of the sample received, it was found that the urine sample was sent in a formalin container which was reused after washing. Strong formalin odor was present in the sample. The literature search was done to study the effect of formalin contamination in urine protein estimation resulting in markedly protein estimation.[12]

Case 6

A 10-year-boy was on antiepileptic treatment. Serum phenytoin level was regularly monitored. It was communicated to the laboratory doctor that the measured value of serum phenytoin was below the expected value in accordance with the dosage. It was also observed that the expected levels of drug were always on lower side in outdoor patients. There was no discordance in indoor patients. This prompted the laboratory to perform root cause analysis of the problem. It was found that the sample collection for all outpatients was done at the laboratory collection area using red topped vacutainer with serum separator blood collection tubes whereas for indoor patients samples were collected in red topped blood collection tubes without barrier gels. On literature search, it was found that there are significant differences in therapeutic drug level estimation particularly with reduced sample volumes or prolonged specimen storage with barrier gel vacutainer.

Drug analysis is being more frequently requested on add-on basis requiring specimens that have been previously submitted for a wide range of diagnostic test procedures, therefore, clinical laboratory must be able to monitor therapeutic drug concentration reliably and accurately even when only small volumes of sample (<500 UL) are available. The magnitude of reduction in concentrations of certain therapeutic drugs may be clinically significant when these small volume of sample remain in contact with barrier gels in serum separator blood collection tubes for extended periods.[13]

SUMMARY

Preanalytical phase is an important component of total laboratory quality. Studies show that the preanalytical phase accounts for 46%–68.2% of errors observed. The efforts toward the standardization of preanalytical phase and awareness to the effect of this on various critical parameters of laboratory must be enhanced. The awareness toward recognition of preanalytical errors and by the introduction of strategies to achieve total laboratory quality is finally within our hands.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Lippi G, Blanckaert N, Bonini P, Green S, Kitchen S, Palicka V, *et al*. Causes, consequences, detection, and prevention of

identification errors in laboratory diagnostics. Clin Chem Lab Med 2009;47:143-53.
2. Wallin O, Söderberg J, Van Guelpen B, Stenlund H, Grankvist K, Brulin C. Preanalytical venous blood sampling practices demand improvement – A survey of test-request management, test-tube labelling and information search procedures. Clin Chim Acta 2008;391:91-7.
3. Narayanan S. The preanalytic phase. An important component of laboratory medicine. Am J Clin Pathol 2000;113:429-52.
4. Lippi G, Chance JJ, Church S, Dazzi P, Fontana R, Giavarina D, *et al*. Preanalytical quality improvement: From dream to reality. Clin Chem Lab Med 2011;49:1113-26.
5. Kalra J. Medical errors: Impact on clinical laboratories and other critical areas. Clin Biochem 2004;37:1052-62.
6. Carraro P, Plebani M. Errors in a stat laboratory: Types and frequencies 10 years later. Clin Chem 2007;53:1338-42.
7. Sheppard C, Franks N, Nolte F, Fantz C. Improving quality of patient care in an emergency department: A laboratory perspective. Am J Clin Pathol 2008;130:573-7.
8. Szecsi PB, Ødum L. Error tracking in a clinical biochemistry laboratory. Clin Chem Lab Med 2009;47:1253-7.
9. Sciacovelli L, Plebani M. The IFCC Working Group on laboratory errors and patient safety. Clin Chim Acta 2009;404:79-85.
10. Goswami B, Singh B, Chawla R, Mallika V. Evaluation of errors in a clinical laboratory: A one-year experience. Clin Chem Lab Med 2010;48:63-6.
11. Don BR, Sebastian A, Cheitlin M, Christiansen M, Schambelan M. Pseudohyperkalemia caused by fist clenching during phlebotomy. N Engl J Med 1990;322:1290-2.
12. Miler M, Simundic AM. Low level of adherence to instructions for 24-hour urine collection among hospital outpatients. Biochem Med (Zagreb) 2013;23:316-20.
13. Dasgupta A, Dean R, Saldana S, Kinnaman G, McLawhon RW. Absorption of therapeutic drugs by barrier gels in serum separator blood collection tubes. Volume-and time-dependent reduction in total and free drug concentrations. Am J Clin Pathol 1994;101:456-61.