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EDITORIAL

No Preanalytical Errors in Laboratory Testing: A Beneficial Aspect for Patients

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Laboratory services are the backbone of the modern health care sector. Effective laboratory service is the amalgamation of precision, accuracy, and speed of reports delivered to the patient. In spite of rapid advances in laboratory science, it is still susceptible to various manual and systemic errors. Various types of errors that we, as clinical biochemists, encounter in the laboratory are classified as preanalytical, analytical, and postanalytical, depending upon the time of presentation. The preanalytical phase is an important component of laboratory medicine [1]. It includes specimen collection, handling and processing variables, physiological variables, and endogenous variables. Some of the preanalytical variables such as specimen variables can be controlled, while knowledge of uncontrollable variables need to be well understood in order to be able to separate their effects from disease related changes affecting laboratory results.

Most errors affecting laboratory test results occur in the preanalytical phase, primarily because of the difficulty in achieving standardized procedures for sample collection. Errors occurring during the preanalytical phase—from the time the test is ordered by the physician until the sample is ready for analysis—can account for up to 70 % of the errors currently encountered during the total diagnostic process [2]. Errors at any stage of the collection, testing, and reporting process can potentially lead to a serious patient misdiagnosis. Overall, insufficient specimen quality and quantity may account for over 60 % of preanalytical errors [3]. The human role in sample collection makes complete elimination of errors associated with laboratory testing unrealistic. Preanalytical errors are largely attributable to human mistakes [4] and the majority of these errors are preventable [5, 6]. This is understandable, since the preanalytical phase involves much more human handling, compared to the analytical and postanalytical phases. The total uncertainty in the test result due to preanalytical reasons can be calculated [7]. For example, differences in preanalytical procedures can explain up to 41 % of the variation of prevalence of hypercholesterolemia [8].

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Types of Errors and Their Rectification

1. *Patient Identification and Preparation*: Errors in correctly identifying the patient are indefensible. Patient identification errors may occur when proper positive patient identification procedures are not followed and specimen tubes are unlabelled or incorrectly labeled. It has been reported by Söderberg et al. [9] that only 12 % technicians labeled the test tubes prior to drawing blood samples. These errors can be rectified by proper identification of patients from identification tag, by asking them their full name and with the help of staff or family member if patient is unable to identify him/herself. Specimen collection tubes should be labeled sufficiently with patient's full name and date/time of collection.
2. *Sample Collection Procedures, Handling, and Processing*: *(proper venipuncture technique, order of draw, proper tube mixing, and correct specimen volume)*: Order of draw affects the quality of the sample and can lead to erroneous test results due to contamination with the additive from the previous blood collection tube. Preanalytical errors can also result if the blood collectors are not aware of the

standardized posture guidelines. Sitting versus lying can vary lab test results of some chemical constituents (cholesterol, aldosterone).To avoid hemolysis, blood comparable to additive in tube should be collected, traumatic venipuncture, and vigorous shaking of tubes after collection should be avoided. Hemolysis, lipemia, and icterus have variable effects on assays. The degree to which the accuracy of the assay is affected is both method and analyte dependent. Some assays are affected by very low levels of hemolysis, lipemia, or icterus, while there is minimal or no effect on other assays. Hemolysis interference may be analytic (the presence of hemoglobin interferes with the measurement of an analyte) or physiologic (caused by the release of the substance being measured from red cells into the serum or plasma). Two common examples of physiologic interference by hemolysis are potassium and aspartate aminotransferase (AST), assays that are very sensitive to the effects of hemolysis. Few studies have demonstrated that preanalytic errors are less common when dedicated laboratory personnel collect blood samples as opposed to nursing or other health care personnel. Sheppard et al. [10] reported that when the phlebotomy was performed in an emergency department by dedicated laboratory technologists, there was a reduction in overall turnaround time, and blood culture contamination rates dropped from 5.0 to 1.1 %.In addition, blood draws from indwelling catheters or during IV starts are more prone to hemolysis compared to venipuncture draws [11].

3. *Specimen Transport*: Transport of blood specimens in the proper manner after collection ensures the quality of the sample. Some specimens must be transported immediately after collection, for example arterial blood gases. Specimens for serum or plasma testing should be centrifuged and separated within 2 h. Transportation should be done at appropriate temperature depending upon the required test. Some samples need to be protected from light, for example, bilirubin. This area needs improvement initiatives, as there is an increasing trend towards consolidation of laboratory facilities, with a consequent need for long-distance sample transportation [12].
4. *Errors in Laboratory Tests Related to Gastrointestinal Diseases*: Being the Chief of Clinical Biochemistry of Gastroenterology department, I have realized that serious preanalytical errors can occur during various tests for gastrointestinal diseases.

    - For reducing errors in urine D-xylose test for malabsorption, patients should be given proper instructions on how the test needs to be done. They should be instructed that no food or fluids (the patient may consume water) can be consumed during 12 h prior to the scheduled testing. After emptying the urinary bladder, the patients need to have 5 g D-xylose dissolved in one glass of water. They should drink at least ten glasses of water, but no other food or fluids during the testing period. Do not allow the patients to smoke during 5 h testing period. Standard precautions should be kept in mind while collecting and transporting urine.
    - For reducing errors in non-invasive hydrogen breath test to diagnose small intestinal bacterial overgrowth, orocecal transit time and lactose intolerance, patients should be inquired about other tests they are undergoing as advised by Gastroenterologists. There should be at least 4–5 days difference between barium meal follow through test and 5–6 days difference between colonoscopy or sigmoidoscopy and hydrogen breath test to avoid false positive and negative results, respectively. Patients should be instructed not to take any antibiotic 4 weeks prior to the test. They should be advised to consume simple food and specifically avoid high fiber food items 3 days before the test to avoid false negative results.
    - For avoiding errors in basal acid output (BAO) measurement, patients should be instructed not to take proton pump inhibitors at least 7 days before the test to avoid false negative results.
    - To get accurate results for adenosine deaminase (ADA) measurement in body fluids, the fluids extracted should not contain hemolysed blood or pus cells as this may result in high levels for ADA.

5. *Other Errors*: Missing sample and/or test request, contamination from infusion route, insufficient samples, and inappropriate containers.

Thus, the preanalytical phase is known to be error-prone but recently data been collected to demonstrate that the errors occurring are mainly related to procedures performed outside the laboratory walls, by healthcare personnel not under the direct control of clinical laboratory [13].

Conclusion

To improve patient safety in laboratory testing, all healthcare providers should survey their preanalytical procedures and improve the total testing process with a systems perspective. Preanalytic error prevention requires excellent communication and cooperation among all members of the health care team, from the phlebotomist who collects the specimens, to the courier who picks up the

samples for transport to the testing laboratory, to the personnel receiving the specimen. Quality improvement initiatives must therefore take into account preanalytical errors so that problems in specimen preparation, centrifugation, aliquot preparation, pipetting, and sorting can be avoided.

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