

Pre-analytical quality assurance: a biomedical science perspective

The accuracy of laboratory result can be affected by a range of factors, particularly those found in the pre-analytical phase of the testing process.

Problems often arise before the specimen reaches the laboratory, so acknowledging and reporting error is vital, as Francis Ajeneye explains.

Pre-analytical errors are misleading results caused by problems that occur prior to sample analysis. Controlling pre-analytical factors prior to testing is a critical factor in ensuring accurate results and is essential to patient safety. The quality of results provided by the laboratory is dependent on the control of pre-analytical factors such as specimen collection, specimen handling, interfering substances and patient-related factors, as it has been estimated that 32–75% of errors occur in the pre-analytical phase.

Guidelines for collecting samples and for evaluating submitted specimens during the analysis cycle (Fig 1) therefore are essential because such factors could affect patient care, and their identification and the use of continuous audit promotes quality improvements across the laboratory services.

SPECIMEN COLLECTION

The quality of laboratory results is dependent, from the very beginning, on proper patient identification and on the quality of the sample. Specimen collection protocols and techniques have a major effect on the quality of the sample. In multiple-tube collection systems, cross-contamination may occur if the collection protocol is not followed. Serum samples must be collected first, followed by those samples that contain a clot activator.

The site of venepuncture should be cleaned with 70% ethanol, and then allowed to dry in order to prevent the patient

experiencing a burning sensation and to prevent specimen haemolysis. It is also important to mix the sample tubes adequately.

Other pre-analytical factors that can affect the quality of results include needle size and vein size: a fine needle can cause haemolysis, and if a vein is traumatised during collection the first tube will be haemolysed and under filled, altering the ratio of blood to

anticoagulant. However, catheter collection, which is very common in the acute care setting, shows the highest rate of sample haemolysis.

SPECIMEN TRANSPORTATION

It is essential to be aware of the means used to transport specimens to the laboratory, as poor transportation can render the specimen unsuitable for analysis. Delayed separation results in loss of potassium (K^+), magnesium (Mg^{2+}), phosphate (PO_4^{2-}) and the enzymes lactate dehydrogenase (LDH), alanine aminotransferase (ALT) and aspartate transaminase (AST); while coagulated samples require rapid analysis if not preserved. Furthermore, ribonucleic acid (RNA) is rapidly lost without centrifugation.

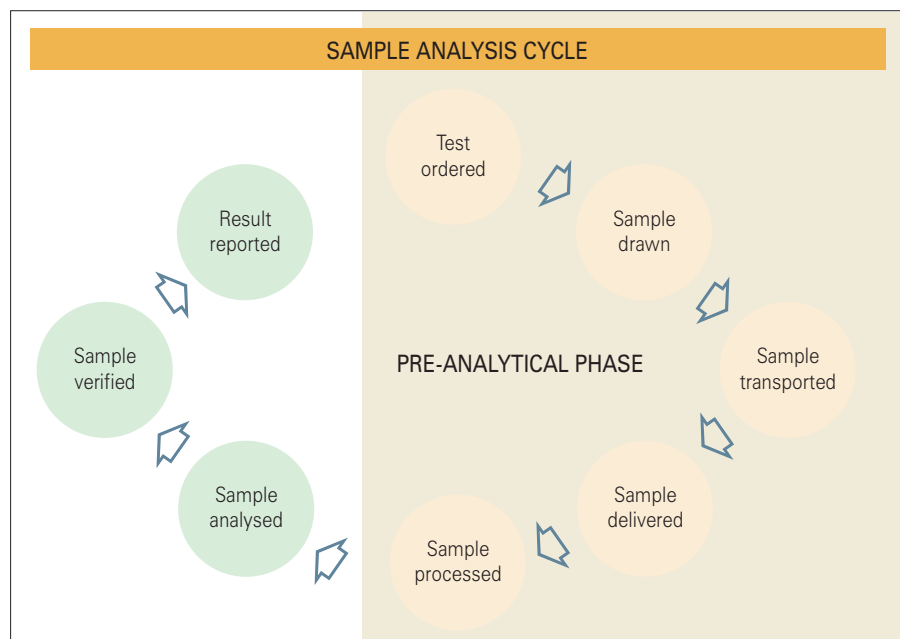


Fig 1. The analysis cycle, from test ordering to result reporting.

Table 1. Some sources of pre-analytical error.

Physiological variation	Collection variation	Transcription variation
Exercise	Incorrect syringe collection	Incorrect test order
Posture	Inappropriate anticoagulant	Presampling labelling
Diet	Tube interferences	Incorrect barcoding
Cyclical changes	Intravenous contamination	Request form design
Medication	Haemolysis	Similar test names
Stress	Inadequate sample volume	Incorrect computer entry
Smoking	Inadequate mixing	Verbal orders

SAMPLE PROCESSING

Adequate centrifugation is required to ensure that all clotted material is removed, and standard operating procedures (SOPs) for sample processing must be followed. Proper centrifugation in the laboratory can prevent analytical problems.

SPECIMEN INTEGRITY

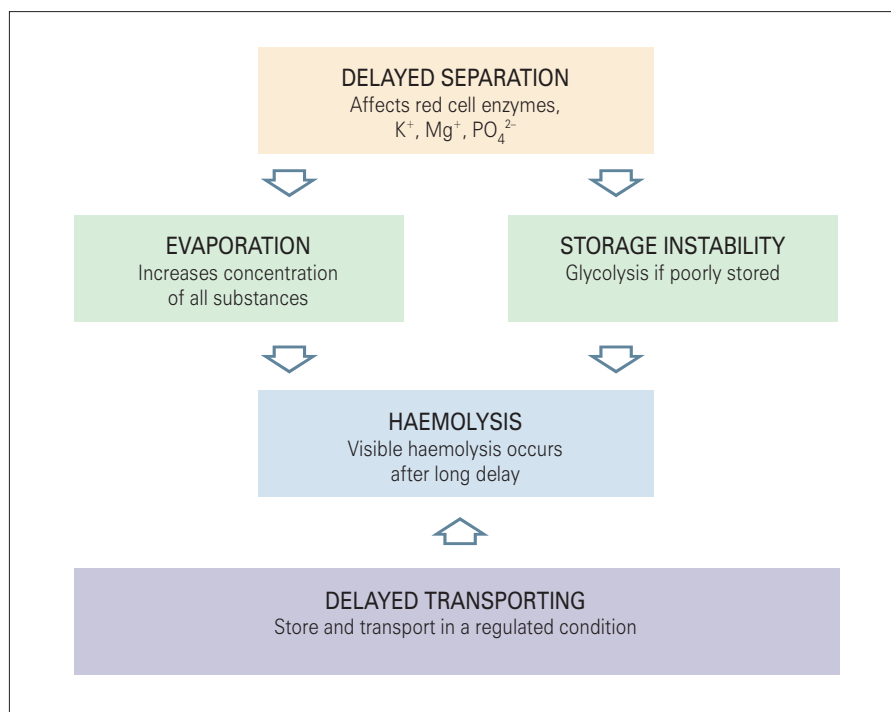
Specimens should be checked for correct labelling prior to analysis. If they are not labelled properly then they should not be analysed and corrective action should be taken. The required volume, based on the hospital protocol, should be checked. Date and time of collection must be checked for suitability of the sample prior to processing. Also, checks should be undertaken for clot, haemolysis or haemodilution. Table 1 gives some sources of pre-analytical error; and post-collection changes are shown in Figure 2.

MANAGING PRE-ANALYTICAL ERROR

With regard to analytical quality, clinicians depend on the laboratory for the detection and correction of errors; thus, the following points should be addressed:

- define laboratory errors and their causes, and set up a plan for a corrective strategy
- create a standard for laboratory error detection, and accurately define reporting and error risk
- measure error reduction and demonstrate, via process analysis, a reduction in risk
- create a culture in which the existence of error is acknowledged, as blame, shame and punishment have no part in addressing the problem
- cooperation between medical and non-medical staff outside the laboratory is essential, as is a regular update of the sample collection and transportation protocol for non-laboratory personnel.

‘When using multiple-tube collection systems, serum samples must be collected first, followed by samples that contain a clot activator’

**Fig 2.** Post-collection changes that can occur in a specimen.

‘Guidelines for collecting samples and for evaluating submitted specimens are essential and are a part of continuous audit to promote quality’

ERROR PREVENTION

It is important to define ways to decrease pre-analytical error. An increasing body of evidence demonstrates that error rate has improved significantly over time and is affected by training, qualification of personnel, patient education and patient identification systems.

Consistent specimen quality can only result if potential phlebotomists receive the proper training and acquire the necessary expertise. Also, the use of computerised ordering has improved test requisition and reduced order-related errors.

Pre-analytical error is the most common cause of laboratory error and can occur at any stage of the test cycle. It is advisable, therefore, to implement error prevention techniques at all stages of the analytical pathway, and also create a culture in which errors are reported.

FURTHER READING

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USEFUL WEBSITES

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- www.westgard.com/guest20.htm
- www.biomedcentral.com/1472-6890/1/5

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