Before the Tube Leaves the Bedside

Naglaa Elwkil

Published: 2026-10-12 | DOI: 10.82098/icmed-mag.2026.08.006

ABSTRACT

The reliability of a laboratory result begins long before a specimen reaches the analyzer. In hematopoietic stem cell transplantation, every step of the pre-analytical process, from patient identification to specimen collection and handling, can influence critical clinical decisions. This article explores the essential, often invisible role of transplant nurses in preventing errors and ensuring patient safety, recognizing them as the first analysts in the diagnostic process.

The First Analyst: Pre-analytical Integrity and the Invisible Work of the Hematopoietic Stem Cell Transplant Nurse

Hematopoietic stem cell transplantation (HSCT) is one of the most complex areas of healthcare, where laboratory results directly influence critical clinical decisions. Clinicians depend on laboratory data to adjust immunosuppressive therapy, monitor complications, guide transfusions, and evaluate treatment response. While significant attention is often given to laboratory analysis, the reliability of a result begins long before a specimen reaches the analyzer.

Consider a familiar transplant scenario. A tacrolimus concentration returns at 21 ng/mL in a patient on day +18 following allogeneic HSCT, exceeding the target range of 8–12 ng/mL. The dose is reduced to prevent toxicity. Two days later, a peripheral sample reports a level of only 4.1 ng/mL. The assay was accurate. However, the initial specimen had been drawn from a catheter lumen previously used for tacrolimus administration, producing a falsely elevated result that did not represent the patient's systemic concentration.

This example highlights a fundamental truth in transplantation: a result can be technically correct while clinically misleading. The prevention of such errors relies heavily on activities occurring before laboratory analysis. In this phase, transplant nurses play a vital role and can rightly be considered the first analysts in the testing process.

Why the Pre-Analytical Phase Matters

All clinical areas collect blood specimens, but transplantation presents unique risks. Patients

 © 2026 ICMED S.r.l.

are often profoundly immunocompromised, pancytopenic, and physiologically unstable. Small changes in laboratory values can trigger immediate interventions, including antimicrobial escalation, electrolyte replacement, blood transfusion, or modification of immunosuppressive therapy.

Many HSCT patients have multi-lumen central venous catheters used simultaneously for medications, blood products, intravenous fluids, parenteral nutrition, and therapeutic drug administration. These devices provide essential access but also increase the potential for specimen contamination.

In addition, transplant medications frequently have narrow therapeutic windows. Immunosuppressive drug concentrations must be maintained within precise limits to balance the risks of graft-versus-host disease against drug toxicity. Busulfan dosing relies on pharmacokinetic monitoring using accurately timed specimens. Under these circumstances, collection site, timing, and specimen integrity become integral components of the laboratory result.

The Line Is Not a Vein

Central venous catheters often contain residual substances that can interfere with testing. Heparin may affect coagulation studies, while glucose-containing fluids and parenteral nutrition can alter chemistry results. Medications infused through a catheter may remain within or adsorb onto its internal surfaces, subsequently contaminating blood samples.

Tacrolimus and ciclosporin are particularly important examples. Studies have demonstrated that these medications can adhere to catheter material and later appear in collected specimens despite flushing. Consequently, therapeutic drug monitoring samples should not be collected from a lumen previously used to administer the same medication whenever possible.

The preferred approach is collection from a peripheral vein or from a lumen verified as not previously exposed to the drug. When this cannot be achieved, the source of the specimen should be documented clearly, and unexpected results should be interpreted cautiously before clinical decisions are made.

Documentation is important, but it does not make a contaminated specimen reliable. Prevention remains the most effective safeguard.

Timing Is Part of the Result

The accuracy of therapeutic drug monitoring depends on when a specimen is collected as much as on the laboratory measurement itself.

Tacrolimus trough levels, for example, are intended to represent the lowest circulating concentration before the next scheduled dose. A sample obtained even 30 to 40 minutes early may produce a significantly different result. If the actual collection time is not documented, clinicians may unknowingly adjust treatment based on misleading information.

The same principle applies to busulfan pharmacokinetic monitoring, where treatment decisions depend upon precisely timed samples. Delays or early collections can compromise dose calculations and affect therapeutic outcomes.

For this reason, recording the actual collection time should be regarded as a patient safety requirement rather than a documentation exercise. Time is not merely recorded on the result; it is part of the result.

Tube Selection and Order of Draw

Incorrect tube selection or failure to follow the approved order of draw may create additive carryover. EDTA contamination can produce falsely elevated potassium concentrations and falsely reduced calcium levels. In transplant patients, such abnormalities may appear clinically plausible, making the error difficult to recognize.

Similarly, under-filled citrate tubes alter blood-to-anticoagulant ratios and may falsely prolong coagulation studies. This can delay procedures, prompt unnecessary treatment, or trigger investigations into conditions that do not exist.

Haemolysis

Haemolysis is a frequent cause of specimen rejection and analytical interference. It may result from excessive suction during collection, inappropriate equipment, difficult venipuncture, or vigorous shaking of blood tubes.

Haemolysis can falsely elevate potassium and lactate dehydrogenase concentrations, potentially mimicking conditions such as tumour lysis syndrome or transplant-associated thrombotic microangiopathy. Unless recognized promptly, these results may lead to unnecessary investigations and interventions.

Handling and Transportation

Many transplant-related investigations, including flow cytometry, molecular testing, and chimerism analysis, have specific transport and storage requirements. Temperature, specimen type, and processing timelines differ between tests and receiving laboratories.

A specimen may be collected perfectly but still become unsuitable if transported or stored incorrectly. Understanding these requirements is therefore an essential part of the collection process and not merely a laboratory responsibility.

Blood Volume Matters

During marrow aplasia, HSCT patients have a limited ability to replace blood losses. While individual collection tubes appear insignificant, repeated daily testing, unnecessary recollections, excessive discard volumes, and rejected specimens can contribute substantially to iatrogenic blood loss.

These cumulative losses may increase transfusion requirements and add to patient burden. Appropriate test utilization, avoidance of unnecessary repeat collections, and adherence to validated collection procedures can reduce avoidable blood loss and support patient blood management strategies.

Patient Identification: When Wrong Results Look Right

Among all pre-analytical errors, misidentification remains one of the most serious.

Patient identification should always be verified using two approved identifiers, and specimens should be labelled immediately at the bedside. Pre-labelling tubes or delaying labelling increases the risk of error.

In transplantation, identification mistakes can be particularly challenging to detect. Following ABO-incompatible transplantation, blood group findings may change over time and present unexpected but legitimate patterns. Consequently, a mislabeled specimen may produce results that appear plausible rather than obviously incorrect.

Making It a System, Not a Habit

Reducing pre-analytical errors requires more than individual vigilance. Effective programmes incorporate education, competency assessment, and quality monitoring.

 © 2026 ICMED S.r.l.

Useful indicators include specimen rejection rates, haemolysis rates, recollection rates, blood-culture contamination, identification errors, and compliance with therapeutic drug monitoring procedures. Tracking these measures allows programmes to identify trends and target improvement efforts.

Competency assessment should also extend beyond policy review. Direct observation of patient identification, collection technique, lumen selection, documentation, and specimen handling provides greater assurance that staff can perform these tasks safely and consistently.

Creating a culture where pre-analytical quality is measured, discussed, and continuously improved helps transform safe practice from a habit into a system.

Conclusion: The First Analyst

In HSCT nursing, the quality of the specimen determines the quality of the result. The nurse who verifies the patient, selects the correct lumen, follows approved collection procedures, records accurate collection times, and ensures proper specimen transport directly influences the reliability of every laboratory result.

The laboratory governs everything that happens after a specimen arrives, and nothing about what is inside the tube when it gets there. That interval has no instrument and no control chart. It has us.

Every result the transplant team acts on has already passed through a nurse's hands. We are not the people who send the sample to the assay. We are the first step of it.

Suggested citation:

Elwkil N. Before the Tube Leaves the Bedside. ICMED Magazine. 2026;2026(8). doi:10.82098/icmed-mag.2026.08.006

 © 2026 ICMED S.r.l.