International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 32, Issue 4, April 2026 ijppr.humanjournals.com ISSN: 2349-7203

Can Lab Results Detect Organ Problems?

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Received: 19 February 2026 Revised: 28 February 2026 Accepted: 20 March 2026

ABSTRACT

Quality systems are the mainstay of clinical laboratory management. We must continually monitor and evaluate our comprehensive laboratory testing process to ensure reliable test results and lay the foundation for quality improvement. The last two decades have witnessed phenomenal advances in medicine, driven by revolutionary changes in the application of technology; as a consequence, Biochemistry and Microbiology have evolved into the most important branches of evidence-based medicine. The quality of any laboratory test result is dependent on many variables. It begins with skill, and knowledge when preparing the patient and specimen is essential to the provision of the highest quality standards for testing and services. Laboratory tests are highly effective at detecting early signs of organ damage, dysfunction, or disease, often before physical symptoms appear. Blood chemistry panels and urine tests measure enzymes, proteins, electrolytes, and metabolic waste products to evaluate how well organs like the kidneys, liver, and heart are functioning. The practice of medicine in the modern era is exclusively evidence-based, focusing on justifiable laboratory reports contributing to effective and opportune patient management. For many years, clinical laboratories have gained astounding significance in medical care services. Laboratory investigations are essential for medical diagnosis in patient care as well as medical research.

Keywords: Clinical laboratory management, Troponin test, B-type natriuretic peptide (BNP), High bilirubin, Creatine phosphokinase (CPK or CK).

INTRODUCTION

The significance of laboratory medicine is seen from the fact that 66 % of clinical decisions were based on laboratory tests, as shown by a recent study (1).

Laboratory investigations also form an important component of biomedical research. Though the principles of medical ethics- autonomy, beneficence, non-maleficence, and justice- are thought of largely in the context of clinician-patient interaction, they also include the pathologist-patient interaction (2).

The lack of direct contact of pathologists with patients. Issues unique to laboratory medicine include the use of residual samples for research, autopsies, and the use of microscopic images. (3)

Implied consent is usually considered sufficient for most investigations, as the patient presents himself/herself voluntarily to the laboratory. (4)

If the patient (or the EC) denies permission for the storage of his or her tissue for research purposes, that decision must be respected. It goes without saying that confidentiality must always be maintained. The pathology laboratory thus plays the role of guardian, rather than proprietor, of stored body samples (5,6).

Clinical laboratories should be updated to reflect current rules and regulations (7).

Laboratories should hire personnel who are trained in and display professional ethics, positive patient relations, diligence to the job, and observation of safety protocols (8).

Positive outcomes and patient safety depend strongly on handling specimens in standard ways (9).

Good and effective health services with respect and equal treatment without considering economic, racial, cultural, religious, political, and social reputations is the right of every patient (10).

Laboratory staff should respect their profession and the reliability of their colleagues. They need to enhance their professional qualifications by strengthening their academic background and working collaboratively with other laboratories (11).

General training and discussion about ethical aspects in clinical laboratories should be implemented for the public to increase awareness about human rights and ethics in laboratories (12).

The progress of knowledge and technology in the diagnosis, treatment, and prevention of diseases has significantly changed medicine (13).

All urologists frequently encounter difficulties in making the correct diagnosis of a patient's clinical problem that prompts them to order diagnostic tests. (14).

A diagnostic test's validity, or its ability to measure what it is intended to measure, is determined by sensitivity and specificity (15).

Specificity is the percentage of true negatives out of all subjects who do not have a disease or condition (16).

Sensitivity and specificity are inversely related: as sensitivity increases, specificity *tends to decrease*, and vice versa. Highly sensitive tests will lead to positive findings for patients with a disease, whereas highly specific tests will show patients without a finding having no disease (17).

Sensitivity and specificity should always merit consideration together to provide a holistic picture of a diagnostic test (18).

The Medical Council of India Vision 2015 document, although not specifically mentioning diagnostic errors, does stress diagnostic skills as one of the competencies required for the Indian Medical Graduate (19).

Diagnostic errors, defined as a diagnosis that is missed, wrong, or delayed, as detected by some subsequent definitive test or finding, are gradually receiving significant attention from researchers and the authorities (20).

How to know which organ is affected just by looking at the lab results?

1. Blood chemistry tests

The basic metabolic panel (BMP) is a group of tests that measures different naturally occurring chemicals in the blood. These tests are usually done on the fluid (plasma) part of blood. The tests can give providers information about your organs, such as the heart, kidneys, and liver.

The BMP includes blood glucose, calcium, and electrolyte tests, as well as blood tests that measure kidney function. Some of these tests require you to fast (not eat any food) before the test, and others don't.

2. Blood enzyme tests

- Blood enzyme tests may be used to check for heart attack. Enzymes are chemicals that help control chemical reactions in your body. There are many types of blood enzyme tests. The ones for heart attack include troponin and creatine kinase (CK) tests.

Troponin--Heart injury

A troponin test measures troponin levels (I or T) in the blood, which are released when the heart muscle is damaged, such as during a heart attack. It is a critical, highly sensitive diagnostic tool used in emergency settings for patients with chest pain or other heart attack symptoms. Elevated levels directly indicate heart injury.

Key Aspects of the Troponin Test:

- **Purpose:** Primarily to confirm or rule out a heart attack. It is also used to monitor unstable angina and assess heart damage after surgery.

- **Procedure:** A standard blood sample is taken from a vein, often repeated over several hours to monitor rising or falling levels.
- **Results:** In healthy adults, troponin levels are usually so low that they are undetectable.
- **Elevated Levels:** Higher-than-normal levels indicate heart damage. While often indicating a heart attack, elevated levels can also be caused by heart failure, sepsis, pulmonary embolism, or chronic kidney disease.
- **Timing:** Troponin levels typically begin to increase in the blood within 2 to 3 hours after the onset of a heart attack.
- **3. Lipoprotein panel**

A lipoprotein panel, also called a lipid panel or lipid profile, measures the levels of LDL and HDL cholesterol and triglycerides in your blood. Cholesterol and triglyceride levels that are higher or lower than normal may be signs of a higher risk of coronary heart disease.

A lipoprotein panel gives information about your:

- **Total cholesterol**
- **LDL ("bad") cholesterol,** which is the main source of cholesterol buildup and blockages in the arteries.
- **HDL ("good") cholesterol,** which helps decrease cholesterol blockages in the arteries.
- **Triglycerides**, which are a type of fat in your blood.

4. B-type natriuretic peptide (BNP)

It is a hormone produced by the heart's left ventricle in response to increased pressure and volume overload.

As a diagnostic marker, high blood levels indicate heart failure (usually >100 pg/mL), helping distinguish cardiac from pulmonary issues.

Key Aspects of B-Type Natriuretic Peptide:

- **Function:** BNP helps manage blood flow by dilating blood vessels and prompting the kidneys to remove excess water and salt through urine.
- **Heart Failure Monitoring:** The test measures the severity of heart failure and checks if treatments are working, as levels rise when the heart is overstressed.
- **Normal vs. High Ranges:** A normal level is generally under. Higher levels, such as above 50, are indicative of acute heart failure.

.5. The estimated glomerular filtration rate (eGFR)

It is a test that measures your level of kidney function and determines your stage of kidney disease. Your healthcare team can calculate it from the results of your blood **creatinine** test, your age, body size, and gender. If your eGFR number is low, your kidneys may not be working as well as they should. People with a lower eGFR are at increased risk of having **chronic kidney disease (CKD)** progress to kidney failure. The sooner that kidney disease is found, the better the chance of slowing or stopping it from getting worse.

First stage------- Kidney damage with a normal kidney function

Second stage----Kidney damage with mild kidney loss

Third stage-a----Mild to moderate

Fourth stage--b--Moderate to severe

Fifth stage--------Kidney failure

6. High bilirubin--Liver

High bilirubin (hyperbilirubinemia)--

More than 1.2 mg/dL often indicates liver dysfunction, Gall bladder issues, or accelerated red blood cell breakdown, leading to jaundice, dark urine, and fatigue.

Common causes include hepatitis, gallstones, or Gilbert's syndrome. Treatment depends on the underlying cause, which requires diagnosis by a doctor.

Key Symptoms

When bilirubin levels rise, symptoms may include:

- **Jaundice:** Yellowing of the skin and eyes.
- **Dark Urine:** Urine may appear brown or tea-colored.
- **Abdominal Pain:**

Pain, particularly in the upper right quadrant, or swelling.

- **Digestive Issues:** Pale or clay-colored stools, nausea, and vomiting.
- **Other Symptoms:** Fatigue, fever, chills, or intense itching (pruritus).

Common Causes

High bilirubin is categorized by where the disruption occurs in the body:

- **Pre-hepatic (Before liver):** Increased breakdown of red blood cells (hemolysis).
- **Hepatic (Within the liver):** Liver damage or diseases such as viral hepatitis, cirrhosis, or cancer.
- **Post-hepatic (After liver):** Obstruction of bile flow due to gallstones, tumors, or bile duct strictures.
- **Genetic Conditions:** Gilbert's syndrome (harmless, common) or Crigler-Najjar syndrome (rare).

7. High Ammonia--Brain damage

High ammonia (hyperammonemia)

Causes several neurological damages by forcing ammonia into the brain, resulting in astrocyte swelling, cerebral edema, and permanent damage.

Often caused by liver disease or metabolic disorders, it requires immediate treatment to avoid irreversible neurotoxicity, cognitive impairment, and death.

Mechanisms of Brain Damage

- **Cerebral Edema:** High ammonia levels cause astrocytes (support cells in the brain) to swell, leading to increased pressure and brain swelling.

- **Neurotoxicity:** Ammonia induces oxidative stress and inflammatory responses, causing neuronal apoptosis (cell death).

- **Neurotransmitter Imbalance:** It alters the neurotransmitter system and causes ATP depletion, resulting in seizures and neuronal dysfunction.

Symptoms of Ammonia-Induced Brain Injury

- **Early:** Irritability, confusion, forgetfulness, vomiting, and lethargy.

- **Severe:** Disorientation, ataxia, slurred speech, seizures, deep coma, and death.

Common Causes

- **Hepatic Encephalopathy:** Advanced liver disease (cirrhosis) prevents the liver from processing ammonia.

- **Urea Cycle Disorders (UCDs):** Genetic conditions that impair the body's ability to eliminate nitrogen.

- **Non-cirrhotic causes:** Infections, medications (like valproic acid), and kidney failure.

Management and Prevention

- **Rapid Treatment:** Immediate reduction of ammonia levels is necessary, often using nitrogen-scavenging medications or hemodialysis.

- **Long-term Management:** Adhering to a low-protein diet and taking prescribed medications is crucial to prevent irreversible neurological damage.

8. Blood clotting tests

Blood clotting tests are sometimes called a coagulation panel. These tests check proteins in your blood that affect the blood clotting process. Levels that are higher or lower than normal might suggest that you're at risk of bleeding or developing clots in your blood vessels.

9. Bone marrow tests

Bone marrow tests

Bone marrow tests check whether your bone marrow is healthy and is making normal amounts of blood cells. The two bone marrow tests are aspiration and biopsy.

- **Aspiration** collects a small amount of bone marrow fluid through a larger needle.

- **Biopsy** tests are often done at the same time as the aspiration test. A biopsy test collects a small amount of bone marrow tissue through a larger needle.

These tests can help find the cause of low or high blood cell counts. They also play an important role in checking how well treatments for certain types of cancers, such as leukemia or lymphoma, are working.

Common causes of poor performance

Some common reasons of not getting quality and reliable results are

1. Lack of commitment on the part of the staff performing the tests

2. Poor management and supervision

3. Poor understanding of quality assurance concepts

4. Analysts do not understand the concepts of assay principles

5. Reagents used are not of high quality

6. Poor quality of instruments

7. Procedures are not followed as recommended

8. Under-staffing leads to a high error rate.

9. Lack of equipment.

10. Mislabeling the blood sample.

11. Unlabeling the blood sample.

Blood tests

Changes in blood on keeping:

1. Loss of carbon dioxide occurs between the cell and plasma by biochemical changes. In order to prevent the loss of carbon dioxide, the blood is collected under liquid paraffin and plasma separated immediately.

2. Glucose in blood is fairly reduced from whole blood on standing. Nearly half the glucose is lost in two to three hours. If the technician does the test immediately, gets right value and after doing the test with late hour, gets wrong value. This is due to glucose is converted in to lactic acid, by a process known as glycolysis.

3. This can be prevented by adding sodium fluoride to the anticoagulant. A mixture of sodium fluoride and potassium oxalate will prevent any loss of glucose for two or three days.

4. Formation of ammonia from nitrogenous substances, mainly urea, may occur in blood that has been contaminated with bacteria. To overcome this error, blood should be kept in a sterile or refrigerator.

5. Potassium is present in greater concentration in the cells than in plasma. Serum heparinized plasma should be separated shortly after taking the blood. Diffusion of potassium occurs more rapidly in blood kept at 4c than at room temperature.

6. The pyruvate present in blood is converted into lactic acid, is catalysed by lactic acid dehydrogenase. After collection, the blood should be mixed immediately with a protein precipitant to get the correct value.

Types of blood to be used.

1. **Whole blood**:

Ammonia, barbiturates, carboxy hemoglobin, glucose, hemoglobin, lead, urea, pyruvate, sulphonamides, and non-protein nitrogen etc.

2. **Serum:**

Albumin, globulin, aldolase, amino acids, amylase, bilirubin, bromide, calcium, cholesterol, copper, creatinine, creatine, creatine kinase, iron, isocitrate dehydrogenase, lactate dehydrogenase, lipase, lipids, magnesium, phosphorus, acid phosphatase, alkaline phosphatase, Protein -bound iodine, salicylates, sodium, transaminases, uric acid, vitamin A.

3. **Plasma**: Ascorbic acid, bicarbonate, fibrinogen.

4**. Red cells-----**Glucose 6 phosphate dehydrogenase, pyruvate kinase, abnormal hemoglobin.

5. Glucose, Urea, Uric acid, and Creatinine can be estimated both in serum and plasma, as there will be no interference.

Does and Undo s

1. Acid phosphatase is present in red blood cells. A haemolysed sample gives high results.

2. Red blood cells are rich in LDH, hence avoid haemolysis. Haemolysed samples should not be assayed.

3. Creatine phosphokinase(CPK or CK). It is not found in Red blood cells, and its level is not affected by haemolysis.

4. For the most accurate blood sugar testing, wash your hands with soap and dry thoroughly before testing.

5. Using expired or poorly stored strips can result in accurate reading.

6. The driver may be efficient, but it depends on the machine. Check the blood sugar meter accurately, periodically.

Testing Blood sugar immediately after meals or snacks will give you results that are probably too high. Wait for two hours after eating to get the best reading.

A cardiologist says this blood tests can predict heart disease risk

1. Cholesterol & Genetic Risk: "Lipid panel – LDL, HDL, triglycerides; Lipoprotein(a) – one-time genetic check; ApoB – counts all harmful cholesterol particles."

2. Blood Sugar Control: "A1C – 3-month average; Fasting glucose – diabetes screen".

3. Kidney & Metabolic Health: "Creatinine & eGFR – kidney function; Electrolytes – sodium, potassium, calcium."

4. Hormones & Inflammation: "Thyroid (TSH, T4) – rhythm & metabolism; CRP – inflammation marker; Vitamin D – linked to heart health".

5. Blood Health: "CBC – anemia & infection clues; Iron & ferritin – oxygen delivery".

Predict Kidney Risk

A blood test that measures the creatinine level to check how well the kidneys filter waste and excess fluids from the blood, and a urine test to check protein leakage, could go a long way in the early detection of kidney diseases.

Blood test to detect Alzheimer's risk

Scientists claim to be one step closer to developing a new blood test which could detect a person's risk of getting Alzheimer's disease at least 10 years before its onset.

A simple blood test can quickly diagnose sarcoidosis: Research

Researchers have developed a blood test to rapidly diagnose sarcoidosis - a chronic inflammatory disease where granulomas develop in the lungs and other organs. A study has created a tool for rapidly and inexpensively diagnosing sarcoidosis, a chronic inflammatory disease characterised by the formation of tiny lumps known as granulomas in the lungs and other organs.

A breakthrough blood test to rapidly identify sepsis on anvil

A life-saving blood test designed to detect sepsis, a fatal complication, has been developed and is currently undergoing trials at two hospitals in the UK. A blood test for sepsis, a life-threatening complication, has been developed and is currently in trial at two UK hospitals, reports the Irish Examiner. The much-dreaded condition, also known as blood poisoning, has no test for diagnosis currently, which makes it difficult to identify and treat it.

Conclusion

Laboratory tests, including kidney and liver function tests and cardiac biomarkers, are crucial for detecting and monitoring organ problems, often before symptoms appear. Regular, preventive testing recommended by experts helps identify metabolic issues, anemia, and thyroid dysfunction early.

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How to cite this article:
Dr. Raghavendra Rao M V et al. Ijppr.Human, 2026; Vol. 32 (4): 44-51.
Conflict of Interest Statement: All authors have nothing else to disclose.