The Use of Tests in Clinical Biochemistry
Interpreting Blood Results

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What is “Clinical Biochemistry”? 
How does it fit into Clinical Medicine? 
What use are Clinical Biochemistry tests? 
What factors affect test results? 
Samples, techniques, instruments 
What tests? 
Result interpretation
What is Clinical Biochemistry?

Application of chemical, molecular and cellular concepts and techniques to the understanding and evaluation of human health and disease
What is Clinical Biochemistry?

• Disease is frequently caused by, or associated with, changes in the complex biochemistry of the body, and an understanding of these changes is essential to the diagnosis and treatment of patients.

• Clinical Biochemistry deals with the detection and measurement of the chemical constituents of body fluids and excretions.
Clinical Biochemistry

Alterations in body constituents → organ dysfunction

Organ damage leads to leakage of proteins etc into blood

Biochemical measurements (Blood tests) are useful in screening, diagnosis and monitoring disease and monitoring the effect of treatment
Uses of Laboratory Tests

- Support or refute diagnosis
- To extend clinical diagnosis with information on causation
- To detect complications, including treatment complications
Uses of Laboratory Tests

• To monitor progress of a condition

• To detect sub-clinical disease (Screening)
Quality of Laboratory Data

- Quality Management Systems
- Accreditation
- Quality indicators:

  Analysis: Precision (QC)
  Accuracy (QC and EQA)
  TAT
  Clinical Advice/interpretation
Other Factors affecting results

Pre-analytical

- Correct: Patient, Sample, Time, Draw order
- Appropriate preservation and handling
- Transport
Other Factors affecting results

Post-analytical

- Calculation errors
- Transmission errors (Telephoning)
- Transcription errors
Test Samples

Blood
• Whole Blood
• Plasma (Anticoagulant)  (Gel)
• Serum  (Gel)

Urine

Fluid  (Pleural, ascitic, cyst, drains etc.)

Other
Test Requirements

Most Clinical Biochemistry tests use **Plasma**
e.g. Renal, LFT, Lipids, Haematinics

Specific tests may require **Serum**
e.g. Proteins, Drugs

Some tests use **Whole blood**
e.g. HbA1c
Analysis

Large analysers can do many tests on a single sample tube with <1 mL plasma

Typical test sample volume is 10uL or less
Analysis time from 1 min (electrolytes) to 15 minutes (chemistries and immunoassays)
Methods of Analysis

- Ion specific electrodes
- Spectrophotometry
- Immunoassay
- Electrophoresis
- Nephelometry
Our Instruments

• Roche Chemistry and Immunoassay Analysers - large automated systems in modular form, usually linked to automated pre-analytics.

• Beckman Nephelometry - Specific Proteins
• Sebia Electrophoresis – Monoclonal proteins
• Blood Gas [Point of Care instruments]
Roche Cobas Systems
Roche Pre-Analytics
Beckman Nephelometer
Sebia electrophoresis
Sebia electrophoresis
Radiometer Blood Gas
Our Tests

Liver- Bilirubin, Enzymes, Albumin
Renal- Urea, Electrolytes, Creatinine
Cardiac- Troponin T, Enzymes
Bone- Calcium, Phosphate, Enzymes
Proteins- Immunoglobulins, Electrophoresis
Thyroid, Tumour markers, Haematinics, and specialised testing

App. 2000 samples daily. 24 hour 7-day service
Interpretation of Results

Two questions:

• Is result indicative of health or disease, and if of disease, is it diagnostic of a condition?

• Is result different from previous, and if so, is it clinically significant?
Interpretation of Results

Accuracy important for diagnosis

Precision important for monitoring

Both are essential for high quality results
Precision vs. Accuracy
Interpretation of Results

What is “Normal”? 
Reference ranges make no assumptions about normality. An abnormal result, i.e. outside a reference interval, does not always indicate presence of pathological processes-Nor a ‘normal’ result its absence.

The more ‘abnormal’ a result, i.e. the greater the difference from the reference interval, the greater the probability that it is related to a pathological process.
Interpretation of Results

Reference Range (“Normal Range”) Usually established by testing a small group of ‘healthy’ individuals, e.g 120 in number, to represent the wider population for which the service is provided.

The range of ‘normals’ is calculated from a Gaussian distribution curve – 2SD below and 2SD above the mean, includes 95% of all values.
The Normal Distribution

![Normal Distribution Graph](image)

95%
Interpretation of Results

By definition, 5% of ‘Healthy’ subjects will be classified as Abnormal.

Reference ranges may not be appropriate in other contexts:

Cholesterol - Target
Drugs - Target therapeutic
Interpretation of Results

Multiple testing can provide greater diagnostic accuracy:
Renal profile: Na, K, urea, creatinine
Thyroid function (TFT): TSH and free T4
LFT: Bilirubin, ALT, ALP, GGT, ALB
Iron Studies: Fe, transferrin, % Saturation
Interpretation of Results

Information required apart from result

• Previous / Cumulative results
  - look for significant changes: up/down
    (Trends, condition improving/worsening)

• Clinical information
  - Signs, symptoms, volume status

• Drug/Medication history (Interferences)
Thyroid Function Tests

Hypothyroidism - TSH ↑ fT4 ↓

Hyperthyroidism - TSH ↓ fT4 ↑

And many other permutations -
Sub-clinical Hypo- and Hyperthyroidism
Treatment monitoring
Renal Function Tests

AKI- Rapid and significant changes in Creatinine.
Renal Failure- High: creatinine, urea, K^+
Changes in Na reflect water balance, commonly see low Na in hospital patients.
Changes in K due to metabolic disturbances, drugs, haemolysis, delayed separation.
Liver Function Tests

- Bilirubin – levels > 50 μmol/L (Jaundice)
- ALT- Very high levels in hepatitis
- ALP- Can be high in cholestasis, Bone
- GGT- Cholestasis, drug induced
- ALB- low synthesis in liver disease

Tests are sensitive for liver dysfunction but not specific.
Abnormal LFT- causes?

• Transient mild abnormalities which are simply impossible to explain
• Drugs – overdose- Acute liver failure
• Alcohol excess- Cirrhosis
• Hepatitis A/B/C- Acute and chronic
• Non-Alcoholic Fatty Liver Disease
Cardiac

Troponin T- A component of cardiac muscle. A cardiac-specific marker for necrosis during cardiac ischaemia, released into circulation. Levels rise within 4-6 hrs post chest pain-Indicates A.M.I, with/without ECG changes CK- enzyme found in all muscle cells, less specific for cardiac muscle.
Haematinics

Complement Haematology tests

Iron studies- Iron, Ferritin

  Low for diagnosis of anaemia
  High in iron overload (Haemochromatosis)

B12/Folate – Low in some forms of anaemia
Summary

• Clinical Biochemistry is a complex and wide-ranging field with a vast array of tests available to users.

• Service provides accurate and timely results using the right tests at the right time, with increased focus on quality and quality systems

• Increased automation and specialisation
Summary

• Laboratory tests involved in 70% of clinical decision/making
• Laboratory workload rising year on year
• Patient–focussed service responsive to needs of users
• Quality matters more and more