

Sub. : Blood and Urine Analysis Notes

Aditya Gachake
B. Pharm.

*

Sr. No. Topic Page No.

- 1] Complete Blood Count (CBC) 01
- 2] Normal Range of Blood constituent 13
- 3] Urinalysis 14
- 4] Normal range of Urine constituent 20
- 5] Imp. Enzymes in Diagnosis of Diseases 21

Clinical Pearls when Interpreting Laboratory Data

- Normal values may vary from laboratory to laboratory, depending on technique and reagent used.
- Normal value may also depend on the patient's age, gender, weight, height, and other factors.
- Laboratory errors are fairly uncommon occurrences; however, they can happen. Potential causes of laboratory error include technical errors, improper calculation, inadequate sample, incorrect sample timing, improper sample preservation, food substance affecting specimen, or medication interference with laboratory tests.
- If laboratory error is suspected, the test should be repeated.
- Remember: Always treat the patient and not the laboratory values.

Blood Analysis

1]. Complete Blood Count (CBC)

Extremely common laboratory test that provide value for

- (A) Hemoglobin (Hgb)
- (B) Hematocrit (Hct)
- (C) White Blood cells (WBCs)
- (d) Red Blood cells (RBCs)
- (e) Mean Corpuscular Volume (MCV)
- (f) Mean Corpuscular Hemoglobin (MCH)
- (g) Mean Corpuscular Hemoglobin Concentration (MCHC)

In additⁿ some lab. may include platelet count & WBC differential

(A) Hemoglobin (Hgb)

Normal Range :

Male : 14-18 g/dL

SI : 8.7-11.2 mmol/L

Female : 12-16 g/dL

SI : 7.4-9.9 mmol/L

Clinical Significance :

↑ Hgb : May be increased in disease such as polycythemia vera, COPD,

may increased in chronic smoker or who engaged in regular vigorous exercise or live at high altitude.

↓ Hgb: In all types of anemia particularly in iron deficiency anemia (IDA), Hgb also ↓ with blood loss, hemolysis, pregnancy, fluid replacement or increased fluid intake.

(B) Hematocrit (Hct) (Volume of blood occupied by RBCs)

Normal Range:

Male: 39% - 50%

SI → 0.39 - 0.50

Female: 33% - 45%

SI → 0.33 - 0.45.

Also called Packed Cell Volume (PCV)

Clinical Significance:

↑ Hct: Associated with polycythemia vera, COPD, individual who lived at high altitude. Also seen in case of dehydration & shock.

↓ Hct: All types of Anemia, blood loss, hemolysis, pregnancy, cirrhosis, hyperthyroidism & leukemia.

(C) Red Blood Cells (RBCs) (Erythrocyte) Count

Normal Range:

Male: $4.2 - 5.9 \times 10^6$ cells/mm³

Female: $3.5 - 5.5 \times 10^6$ cells/mm³

Male: SI 4.2 - 5.9 $\times 10^{12}$ cells /L

Female: SI 3.5 - 5.5 $\times 10^{12}$ cells /L

Clinical Significance:-

↑ RBCs : (Erythrocytosis) are associated with polycythemia vera, high altitude and strenuous exercise

↓ RBCs : Various types of anemia; lymphomas & leukemia; After puberty, female have lower RBCs & Hgb due to menstrual bleeding-

(D) Mean Corpuscular Volume or Mean Cell Volume (MCV)

Normal Range :

76 - 100 $\mu\text{m}^3/\text{cell}$

SI : 76 - 100 fL

Classification :

Macrocytic : Abnormal large size RBCs (MCV) RBCs

Normocytic : Normal size (MCV) RBCs

Microcytic : Small size (MCV) RBCs

Clinical Significance :

↑ MCV : Associated with folate deficiency; alcoholism; vitamin B₁₂ deficiency; chronic liver disease; hypothyroidism; anorexia & use of medication like valproic acid, Zidovudine, stavudine and antimetabolites

↓ MCV : may result from iron deficiency anemia; Hemolytic anemia, lead poisoning & thalassemia.

(E) Mean Corpuscular Hemoglobin or Mean cell Hemoglobin (MCH)

Normal Range:

26-34 pg/cells

SI : 26-34 pg/cells

Classification:

Hychromic:

Hypochromic: cells with low MCH are pale in colour

Hyperchromic: cells with increase MCH

Normochromic: cells with normal amount

Clinical Significance:

↑ MCH : caused by folate or vitamin B₁₂ deficiency; In hyperlipidemia patient, MCH may be falsely elevated because of specimen turbidity.

↓ MCH : associated with iron deficiency amount.

(F) Mean Corpuscular Hemoglobin Concentration or Mean Cell Hemoglobin Concentration (MCHC)

Normal Range:

32-37 g/dL

SI: 320-370 g/L.

Clinical Significance:

↑ MCHC: Associated with Hereditary spherocytosis

↓ MCHC: May be decreased in Iron deficiency anemia; Hemolytic anemia; lead poisoning and thalassemia.

* Reticulocytes

Normal Range:

0.1% - 2.5% of RBCs

SI: 0.001 - 0.025 RBCr

Clinical Significance:

↑ Reticulocytes: (Reticulocytosis) associated with Hemolytic anemia, hemorrhage and Sickle cell disease.

Are also indication of response to treatment of anemia secondary to iron, Vit B12 or folate deficiency

↓ Reticulocytes: As a result of infectious cause;

alcoholism, renal disease (from decreased erythropoietin), toxins, untreated iron deficiency anemia and drug induced bone marrow suppression.

⑥ Platelets

Normal Range:

150,000 - 450,000 / μ L SI : 150 - 450 $\times 10^9$ /L

Clinical Significance:

↑ Platelets : Increased platelets (thrombocytosis, thrombocythemia) may be caused by infection; malignancies; splenectomy; chronic inflammatory disorders (eg. rheumatoid arthritis), polycythemia vera; hemorrhage; iron deficiency anemia; or myeloid metaplasia.

↓ Platelets : (Thrombocytopenia) may occur in autoimmune disorders like idiopathic thrombocytopenia purpura (ITP) and also with aplastic anemia; radiation; chemotherapy; space-occupying lesion in bone marrow; bacterial & viral infection and use of heparin and valproic acid.

(H) WBCs or Leukocyte count

Normal Range:

3200 - 11300 cells/mm³

SF: 3.2 - 11.3 × 10⁹ cells/L

Clinical Significance:

WBCs ↑ : (Leucocytosis) may caused by infection; leukemia; trauma; thyroid storm and corticosteroid use. Emotion; stress and seizure may also increase WBC count. When WBC count is greater than 50,000 cells/mm³, false elevation of Hgb and MCH can occur.

WBCs ↓ : (Leucopenia) may caused by viral infection; aplastic anemia; and in bone marrow depression caused by chemotherapy or anticonvulsant.

* Neutrophils (Polys, segs, PMNs)

Normal Range :

Segs : 36% - 73% SI : 0.36 - 0.73

Bands : 3% - 5% SI : 0.03 - 0.05

Clinical Significance :

↑ Neutrophil \uparrow : (Neutrophilia) is associated with infection ; metabolic disorders (e.g. diabetic ketoacidosis ; uraemia ; response to stress ; emotional disturbance ; burns ; acute inflammation and use of medication such as corticosteroids .

↓ Neutrophils : (Neutropenia) may result from viral infection (e.g. mononucleosis, hepatitis) septicemia ; overwhelming infection ; and use of chemotherapy agents .

Absolute Neutrophil Counts (ANC) is total number of circulating segs and bands and is calculated from eqn

$$ANC = WBC \times \left[(\% \text{ segs} + \% \text{ bands}) / 100 \right]$$

The risk of infection dramatically \uparrow as the ANC decreases . ANC less than $500/\text{mm}^3$ is associated with substantial risk of infection .

* Lymphocytes

Normal Range :

20% - 50%

SI : 0.20 - 0.40

1500 - 4000 / μ L

Clinical Significance :

↑ Lymphocytes : (Lymphocytosis) may be elevated in hepatitis ; mononucleosis ; chickenpox ; herpes simplex ; herpes zoster ; and other viral infection ; Some bacterial infection (e.g. syphilis , brucellosis) ; leukemia & multiple myeloma are also associated with lymphocytosis .

↓ Lymphocytes : (Lymphopenia) may result from acute infection ; burns ; trauma ; lupus ; HIV ; lymphoma .

* Monocytes

Normal Range:

2% - 10%

200 - 800 / μ L

Clinical Significance:

↑ Monocytes: (Monocytosis) may be observed in the recovery phase of some infection; subacute endocarditis (SBE) bacterial endocarditis (SBE); tuberculosis (TB); syphilis; malaria; leukemia and lymphoma.

↓ Monocytes: (Monocytopenia) is usually not associated with specific disease, but may be seen with use of bone marrow suppressive agents or severe stress.

* Eosinophils

Normal Range :

1% - 4%

40 - 400 / μ L

Clinical Significance :

↑ Eosinophils : (Eosinophilia) associated with allergic disorders ; allergic drug reaction ; collagen vascular disease ; parasitic infection ; Immunodeficiency disorder ; and some malignancies .

↓ Eosinophils : (Eosinopenia) commonly attributed to an increase in steroid production .

* Basophils

Normal Range :
less than 1%
10 - 100 / μ L

[~~Centri~~ Basophils contain Heparin, histamine
and leukotrienes]

Clinical Significance:
Increased \uparrow
(Basophilia)

Basophils : may be seen in hypersensitive
reaction to food or medication ;
certain leukemias ; and polycythemia
vera .

* Urinalysis *

Component of the UA are

- | | |
|-------------------------|-------------|
| ① Gross Appearance. | ② PH |
| ③ Specific Gravity (SG) | ④ Protein |
| ⑤ Glucose | ⑥ Ketones |
| ⑦ Blood | ⑧ Bilirubin |
| ⑨ Leukocytes esterase | ⑩ Nitrates |

① Gross Appearance & Colour

On visual examination, the normal urine colour should range from clear to dark yellow.

Some cloudiness is normal and may be caused by phosphates or urates.

Abnormal :

(Pink)

- ① Red-Orange may be caused by presence of myoglobin (from muscle break down from seizures, cocaine, or injuries); hemoglobin; medications (rifampin; phenazopyridine; phenolphthalein; phenothiazines), or foods (beet, carrots, blackberries).

- (B) Blue-Green : may result from administration of amitriptyline, or methylene blue or pseudomonas infection. (pseudomonas)
- (C) Brown-Black : may be associated with presence of myoglobin or porphyrins from porphyria or sickle cell crisis, phenol poisoning or rhubarb ingestion
- (D) Colourless - Diabetes, Diuretics
Deep Yellow - concentrated urine, excess bile pigment, jaundice
- (E) Brown-Black : may be due to L-DOPA, melanin, methyl dopa

(2) Specific Gravity :

Normal Range : from 1.005 - 1.025

Description :

SG is indication of ability of kidney to concentrate urine. Usually low specific gravity would suggest that kidney are not able to concentrate urine appropriately.

Clinical Significance :

Low SG : (Hypoesthesia) may occur in chronic renal failure or Diabetic Insipidus.

High SG : (Hyperesthesia) may associated with dehydration ; excretion of radiologic contrast media, congestive heart failure (CHF), toxemia of pregnancy, increased excretion of glucose or protein greater than 2g/day may also increase urine spec SG.

(3)

pH.

Normal : 4.5 to 8 (Acidic) (Approx. - 6 pH)

Clinical Significance :

Alkaline urine may found in certain UTIs (UTIs caused by urea splitting organisms Proteus, Pseudomonas); renal tubular acidosis; & - with use of acetazolamide or thiazide diuretics.

Acidic urine may be caused by metabolic acidosis ; pyrexia or diabetic ketosis.

④ Proteins :

Normal : from 0 (< 30 mg/dL) to 1 (30-100 mg/dL)

Description: Trace proteins in urine is common clinical finding & often has no clinical significance

Clinical significance :

Repeated +ve tests (proteinuria) of greater than 150 mg/dl may be marker of renal diseases,

cause of protein in urine include diabetic nephropathy; interstitial nephritis, hypertension, fever, exercise, pyelonephritis, multiple myeloma, lupus and severe CHF.

⑤ Glucose & ketones :

Normal : Both Glucose & ketones should be negative.

Clinical Significance : Glucose begin to spill into urine (glucosuria) when serum blood glucose is greater than 180.

Glucose in urine suggest diabetes mellitus or in a known diabetic; may also be associated with Cushing disease, pancreatitis & use of thiazide diuretics, steroids or oral contraceptives.

Excess amount of ketone ~~from~~ form when carbohydrates metabolism is altered. Diabetic ketoacidosis (DKA); starvation; high-protein/low carbohydrate diet & alcoholism may produce ketones in urine.

⑥ Blood :

Normal : should be negative do ~~not~~ trace

Description : Blood in urine (hematuria) may indicate urinary tract damage

Clinical significance :

common cause of ~~urine~~ hematuria are infection, nephrolithiasis, malignancies and benign prostatic hypertrophy (BPH)

False positive result. For blood in urine may occur when povidone iodine is used as a cleansing agent before urine specimen collection.

False negative result for may occur in patient taking high dose of vitamin C or ascorbic acid

⑦ Bilirubin :

Normal range : should be zero to trace

Clinical significance : Bilirubin in urine may be associated with liver diseases (e.g. hepatitis), septicemia or obstructive biliary tract disease. Phenazopyridine or phenothiazines may cause a false positive result for bilirubin in urine.

⑧ Leukocyte Esterase :

Normal Range : Zero to trace

Description : +ve leukocyte esterase provides an indication of WBCs in urine.

Clinical significance : associated with infectious and/or inflammation of urinary tract.

⑨ Nitrites :

Normal value : Negative

Description : Gram negative bacteria are capable of converting dietary nitrates into nitrites.

Clinical significance : presence of nitrites in the urine suggest colonization or infection with gram negative organism.

Normal Range of Urine Constituent

Page No. 20

Date: / /

- ① Specific Gravity : 1.005 - 1.025
- ② pH : 4.5 - 8 Usually approx. 6
- ③ Proteins : 0 (< 30 mg/dL) to
2 (30 - 100 mg/dL)
- ④ Glucose : Negative
- ⑤ Ketone : Negative
- ⑥ Blood : Negative to trace
- ⑦ Bilirubin ^{zero} Negative to trace
- ⑧ Leucocyte esterase : zero to trace
- ⑨ Nitrites : Negative

Imp. Enzymes in Diagnosis of Diseases.

| Serum Enzymes (elevated) | Diseases (Most Imp) |
|---|---|
| (I) Amylase | Acute pancreatitis |
| (II) Serum glutamate pyruvate -transaminase (SGPT) | Liver Disease (hepatitis) |
| (III) Serum glutamate oxaloacetate transaminase (SGOT) | Heart attack (Myocardial Infarction) |
| (IV) Alkaline phosphatase | Rickets, obstructive jaundice |
| (V) Acid phosphatase | Cancer of prostate gland. |
| (VI) Lactate dehydrogenase (LDH) | Heart Attack, liver disease |
| (VII) Creatine phosphokinase (CPK) | Myocardial infarction (early marker) |
| (VIII) Aldolase | Muscular Dystrophy |
| (IX) 5'-Nucleotidase | Hepatitis |
| (X) γ -Glutamyl transpeptidase (GGT) | Alcoholism |