



Data interpretation

(CBC and Urine)

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CBC interpretation objectives

- ▶ Safe CBC interpretation
- ▶ Approach to Anemia
- ▶ Diagnosis and highlight about polycythemia
- ▶ Diagnosis and highlight about thrombocytopenia
- ▶ Diagnosis and highlight about Thrombocytosis
- ▶ Diagnosis and highlight about neutropenia and leukopenia.
- ▶ Diagnosis and highlight about Pancytopenia

Safe CBC interpretation

The major components of CBC are:

1-Hb

2-WBC

3-platelets

If all major components are normal, then it is very less likely you miss a serious disease.

Safe CBC interpretation

1- look at Hb >>if low >> look at other major components (WBCs and Platelets) to not miss bone marrow disease.

2- if there is no striking abnormality of WBC and platelet then check MCV to classify the anemia into microcytic, normocytic or macrocytic.

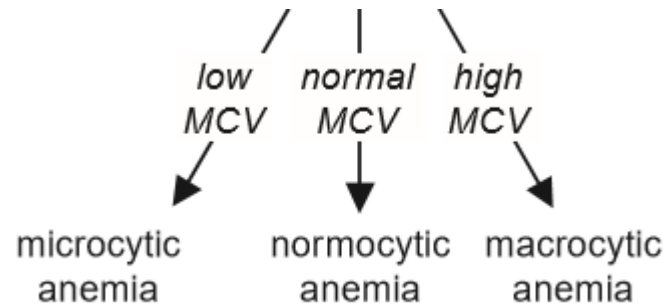
3- some references recommend to check reticulocyte before MCV to not miss hemolytic anemia but not practical.

Diagnosis and approach to Anemia

- ▶ REMEMBER : anemia is a symptom not a disease.

So, look for underlying cause.

- ▶ If other major component are normal and Retics are normal>>> then look at MCV to classify the anemia into : Microcytic, Normocytic or Macrocytic.

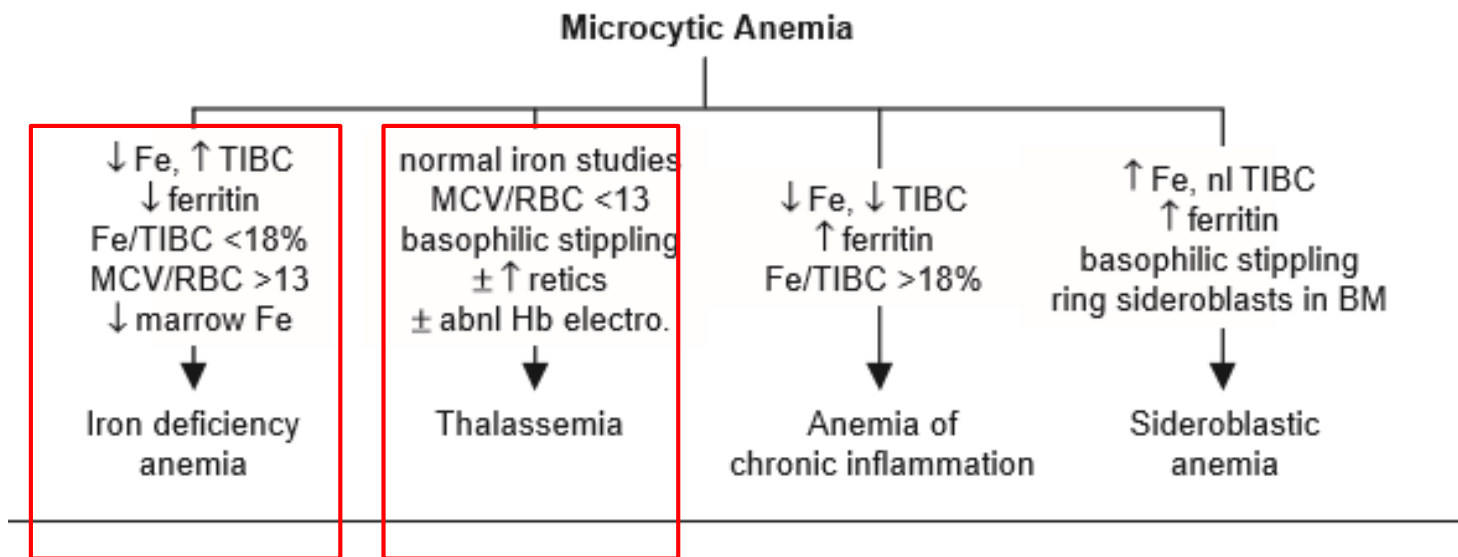


Helpful parameters to diagnose the underlying cause of anemia

- Size of red blood cells (MCV): (small/ normal/ big)
- Abnormal cells on microscopic examination(like blast cells in leukemia)
- Status of leukocytes and platelets (bone marrow function)
- Reticulocyte count (ability of marrow to respond to anemia)>> can help in hemolytic anemia (if high) and in marrow suppression (if low).
- Evidence of destruction(hemolysis) >> (elevated LDH and indirect bilirubin)

Microcytic Anemia

Figure 5-2 Approach to microcytic anemias



The most
common

Iron Deficiency anemia (IDA)

- ▶ Iron studies – Low serum iron
- ▶ High total iron binding capacity (TIBC, transferrin concentration)
- ▶ Low % transferrin saturation
- ▶ Low ferritin (the most sensitive test esp if < 15)

features might help in distinguishing between IDA and Thalassemia

Feature	IDA	Thalassemia
RBC	Low, Low normal	High, High normal
MCV	Mild to moderate low (most likely above 70)	Very low (< 70)
RDW	Mostly High	Mostly normal
Mentzer index: MCV/RBC	> 13	< 13

A 25 year- old lady, presented with 2 months H/O dizziness and fatigue.

WBC	7.0	4	-	11	x10.e9/L
RBC	3.7 L	4.2	-	5.5	x10.e12/L
HGB	90 L	120	-	160	g/L
HCT	28 L	42	-	52	%
MCV	73 L	80	-	94	fl
MCH	23.6 L	27	-	32	pg
MCHC	320	320	-	360	g/L
RDW	15.8 H	11.5	-	14.5	%
PLT	330	140	-	450	x10.e9/L

Hypochromic microcytic anemia
Most likely : IDA

In the last patient (IDA) what do expect the following results?

▶ Ferritin : 
Especially if <15

▶ TIBC : 

▶ Fe: 

▶ Transferrin saturation : 

IDA Treatment

NOTE: Consider upper and lower GI endoscopy for any males (esp. elderly) and postmenopausal women to R/O GI malignancy

- ▶ How much Hb increment is expected with treatment?

Around **2 to 4 g/dL** every three weeks.

(if Hb increased in slower rate >> check for ongoing bleeding??)

- ▶ How long the treatment course is expected?

Oral Fe TID (or less if not tolerated)

(around 6 wk to correct anemia;and 6 months to replete Fe stores).

65 years old gentleman presented with Hx of SOB and generalized weakness

WBC	7.9		4	-	11	x10.e9/L
RBC	3.1	L	4.2	-	5.5	x10.e12/L
HGB	5.7	L	120	-	160	g/L
HCT	24	L	42	-	52	%
MCV	74	L	80	-	94	fl
MCH	23.9	L	27	-	32	pg
MCHC	319		320	-	360	g/L
RDW	16.9	H	11.5	-	14.5	%
PLT	410		140	-	450	x10.e9/L

Most likely IDA
Need Urgent Blood transfusion

Generally The Hb threshold for blood transfusion for asymptomatic patient is <7 g/L

A 31 year old man came for pre-marital checkup .

WBC	8.5		4 - 11	x 10.e 9/ L
RBC	5.9		4.7 – 6.1	x 10 .e12/L
HGB	122	L	130 – 180	g/L
HCT	39	L	42 - 52	%
MCV	63.5	L	80 – 94	fl
MCH	20.4	L	27 – 32	pg
MCHC	317	L	320 – 360	g/L
RDW	14		11.5 – 14.5	%
PLT	177		140 - 450	x 10.e9/L

hypochromic microcytic anemia
Most likely thalassemia

Thalassemia

- ▶ What you will order to confirm Dx?

Hemoglobin electrophoresis (HE).

- ▶ What do you expect in HE?

If HB A2 is **> 3.5** >>> B-Thalassaemia Minor

If HB A2 is **normal** >>> alpha Thalassaemia Minor

Normocytic anemia

▶ DDX of normocytic anemia:

Anemia of chronic inflammation or disease like:

- Chronic kidney disease
- autoimmune disorders
- chronic infection
- malignancy.

A 55 years old gentleman k/c of CKD come for follow up

WBC	8.9		4 - 11	x 10.e 9/ L
RBC	5.1		4.7 - 6.1	x 10 .e12/L
HGB	111	L	130 - 180	g/L
HCT	41	L	42 - 52	%
MCV	88		80 - 94	fl
MCH	30		27 - 32	pg
MCHC	352		320 - 360	g/L
RDW	14		11.5 - 14.5	%
PLT	199		140 - 450	x 10.e9/L

Continue

- ▶ Creatinine : 188(53-106 $\mu\text{mol/L}$)
- ▶ Urea : 7(2.5 to 7.1 mmol/L)
- ▶ eGFR: 34 mL/min/1.73 m^2

- ▶ **what is the Dx:**

normocytic normochromic anemia most likely secondary to CKD.

- ▶ **what is the stage of CKD?**

MACROCYTIC ANEMIAS

- ▶ Megaloblastic :
 - Vitamin B12 deficiency
 - Folate deficiency

- ▶ Non-megaloblastic :
 - Liver disease
 - Myelodysplastic syndrome
 - Increased reticulocyte count
 - Alcoholism >>> :BM suppression & macrocytosis independent of folate/B12 defic.or cirrhosis

A 41 years old alcoholism complain of fatigue

WBC	9.6		4 - 11	x 10.e 9/ L
RBC	5.5		4.7 - 6.1	x 10 .e12/L
HGB	121	L	130 - 180	g/L
HCT	41	L	42 - 52	%
MCV	99	H	80 - 94	fl
MCH	38	H	27 - 32	pg
MCHC	362		320 - 360	g/L
RDW	13		11.5 - 14.5	%
PLT	320		140 - 450	x 10.e9/L

What lab you will order for this patient?

1- Vit b12

2- Folate

Macrocytic hyperchromic anemia

14 years old c.o generalized weakness and yellowish discoloration of skin for 2 days

WBC	9.2	4 - 11x 10.e 9/ L
RBC	5.5	4.7 – 6.1 x 10 .e12/L
HGB	9.5 L	130 – 180 g/L
HCT	41 L	42 - 52 %
MCV	81	80 – 94 fl
MCH	28	27 – 32 pg
MCHC	322	320 – 360 g/L
RDW	14.4	11.5 – 14.5 %
PLT	188	140 - 450 x 10.e9/L

LFT:

Total bilirubin	48 H	(3- 17 umol/L)
Direct bilirubin.....	4	(0 – 5 umol/L)
Total protein	73	(60-80 g/L)
Albumin	38	(35-50 g/L)
Alkaline phosphatase	55	(50-136u/L)
Alanine aminotransferase	40	(20-65 u/L)
Aspartate aminotransferase ...	22	(10-31 u/L)
G.G. Transferase	40	(5-55 u/L)

What you will order to confirm hemolysis?

Reticulocyte is the most important
(LDH will be high and Haptoglobin will be low)

Hemolytic anemia findings

- ▶ High reticulocyte (percentage >4%)
- ▶ High LDH, Low haptoglobin and hemoglobinuria (if intravascular hemolysis)

A 51-year-old man presents with 2 month
H/O of headache

WBC	20.8	H	4	-	11	x10.e9/L
RBC	8.33	H	4.7	-	6.1	x10.e12/L
HGB	201	H	130	-	180	g/L
HCT	62.6	H	42	-	52	%
MCV	82		80	-	94	fl
MCH	28.9		27	-	32	pg
MCHC	329		320	-	360	g/L
RDW	14.0		11.5	-	14.5	%
PLT	300		140	-	450	x10.e9/L

polycythemia

Polycythemia approach

- ▶ What is the most important test to approach polycythemia?

erythropoietin

- ▶ Low erythropoietin >> most likely primary polycythemia (polycythemia Vera)
- ▶ High erythropoietin >> most likely secondary polycythemia (smoking , COPD,hypoxia ..)
- ▶ Polycythemia Vera sometimes combined with high WBC and/or platelet.

32 years old gentleman came for regular check up

WBC	10.9	4 - 11	x 10.e 9/ L
RBC	6.0	4.7 - 6.1	x 10 .e12/L
HGB	14.6	130 - 180	g/L
HCT	51	42 - 52	%
MCV	81	80 - 94	fl
MCH	30	27 - 32	pg
MCHC	340	320 - 360	g/L
RDW	12.8	11.5 - 14.5	%
PLT	86	L	140 - 450 x 10.e9/L

Thrombocytopenia

Thrombocytopenia

- ▶ Thrombocytopenia (ie, platelet count $<150,000/\text{microL}$ [$150 \times 10^9/\text{L}$])
- ▶ Severe spontaneous bleeding is most likely with platelet counts $<20,000$ to $30,000/\text{microL}$, especially below $10,000/\text{microL}$.
- ▶ Surgical bleeding generally may be a concern with platelet counts $<50,000/\text{microL}$
- ▶ DDX is wide and including bone marrow malignancy.

A 48 years old lady c.o leg redness and hotness (cellulitis)

WBC	10.2		4 - 11	x 10.e 9/ L
RBC	5.7		4.7 - 6.1	x 10 .e12/L
HGB	15.6		130 - 180	g/L
HCT	50		42 - 52	%
MCV	91		80 - 94	fl
MCH	31		27 - 32	pg
MCHC	360		320 - 360	g/L
RDW	12.6		11.5 - 14.5	%
PLT	665	H	140 - 450	x 10.e9/L

Thrombocytosis
Most likely reactive

Thrombocytosis

- ▶ patients with elevated platelet counts, the initial diagnostic question is whether their thrombocytosis is
 - ❖ a **reactive phenomenon** (infection, post surgery or Trauma..)
- or
- ❖ a marker for the presence of a **hematologic disorder** (chronic myeloproliferative neoplasms..).

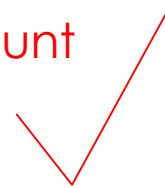
A 28 y old gentleman k/c of AML on chemotherapy c.o Fever

Test Name	Result	Units	Flag	Reference Range
CBC W/ 5 PART DIFF. (X6)				Run by:
WBC	2.2	K/uL		4.0 - 11.2
RBC	4.35	M/uL		4.00 - 5.60
HGB	14.5	gm/dL		12.0 - 16.0
HCT	41.7	%VOL		35.0 - 50.0
MCV	96	fl		82 - 98
PLATELETS	210	K/uL		140 - 440
MCH	33.3	pg		26.0 - 36.0
MCHC	34.7	g/dL		27.0 - 36.0
RDW	12.0	%		9.0 - 18.0
MPV	7.4	fl		6.0 - 12.0
NEU%	42.3	%		45.0 - 65.0
LYMPH%	38.6	%		20.0 - 50.0
MONO%	14.3	%		0.0 - 11.0
EOS%	3.9	%		0.0 - 7.0
BASO%	0.9	%		0.0 - 3.0
NEUT#	0.91	K/uL		2.00 - 8.00
LYMPH#	0.83	K/uL		1.80 - 4.80
MONO#	0.31	K/uL		0.10 - 1.10
EOS#	0.08	K/dl		0.00 - 0.80
BASO#	0.02	K/dl		0.00 - 0.30

Neutrophil percentage



Absolute neutrophil count



Febrile Neutropenia

Neutropenia Vs leukopenia

- ▶ Leukopenia = low WBCs
- ▶ Neutropenia = low absolute neutrophils count (ANC)
- ▶ Leukopenia \neq Neutropenia
- ▶ Febrile Neutropenia is a medical emergency
- ▶ Neutropenia classification is based on Absolute Neutrophil count (ANC)
 - Mild < 1.5 K/uL (1500 cells / MicroL)
 - Moderate <1.0 K/uL (1000 cells / MicroL)
 - Sever < 0.5 K/uL (500 cells / MicroL)

19 years old lady c.o weakness.

WBC	3.1	L	4 - 11	x 10.e 9/ L
RBC	5.7		4.7 - 6.1	x 10 .e12/L
HGB	105	L	130 - 180	g/L
HCT	40	L	42 - 52	%
MCV	90	L	80 - 94	fl
MCH	31		27 - 32	pg
MCHC	362		320 - 360	g/L
RDW	13.3		11.5 - 14.5	%
PLT	117	L	140 - 450	x 10.e9/L

Pancytopenia need a careful management

Pancytopenia D Dx

- ▶ Bone marrow malignancy
- ▶ Viral infection
- ▶ Drug induced

Urine data interpretation

kidney function assessment

- ▶ Assessing kidney function is different from screening for a kidney disease.
- ▶ Measured GFR is the best overall index of kidney function in health and disease.
- ▶ eGFR (estimated GFR) may be the best available way to assess kidney function despite having some limitations.

eGFR staging when there is evidence of kidney pathology (lab, image or histology)

GFR stages	GFR (mL/min/1.73 m²)	
G1	≥90	Normal or high
G2	60 to 89	Mildly decreased
G3a	45 to 59	Mildly to moderately decreased
G3b	30 to 44	Moderately to severely decreased
G4	15 to 29	Severely decreased
G5	<15	Kidney failure (add D if treated by dialysis)

Relative Risk Mortality with eGFR stage and albumin creatinine ration(ACR)

All-cause mortality

	ACR <10	ACR 10-29	ACR 30-299	ACR ≥300
eGFR >105	1.1	1.5	2.2	5.0
eGFR 90-105	Ref	1.4	1.5	3.1
eGFR 75-90	1.0	1.3	1.7	2.3
eGFR 60-75	1.0	1.4	1.8	2.7
eGFR 45-60	1.3	1.7	2.2	3.6
eGFR 30-45	1.9	2.3	3.3	4.9
eGFR 15-30	5.3	3.6	4.7	6.6

UTI

▶ What urine analysis finding could be seen in UTI:

- Positive WBCs :a number of leukocytes (WBCs) $>10/\text{microL}$ indicate significant pyuria
- Positive Nitrite
- Positive leukocyte esterase
- ? Positive RBCs

NOTE: presence of WBCs Cast indicate upper urinary tract infection (pyelonephritis)

▶ Urine culture:

- If > 100.000 (CFU)/mL indicate a positive urine culture

Urine analysis Clinical tips

- ▶ microscopic hematuria (which is defined as 3 RBCs or more per high-power field)
- ▶ red blood cell (RBC) casts is suggestive of glomerular hematuria and an underlying glomerulonephritis
- ▶ Protein in urine analysis can not detect microalbuminuria (early sign of kidney damage in some diseases like diabetic nephropathy).
- ▶ To detect microalbuminuria we need to order urine Albumin/creatinine ratio (A/C ratio).
- ▶ nephrotic pattern is characterized by proteinuria that is usually above 3.5 g/day usually by 24h urine collection.

A 42 year old lady presented with 2 days H/O lower abdominal pain and vomiting

- ▶ NITRITE POSITIVE
- ▶ leukocyte esterase..... negative
- ▶ PH 8.3
- ▶ PROTEIN 1+
- ▶ GLUCOSE NIL
- ▶ KETONE TRACE
- ▶ BLOOD 3+
- ▶ HEMOGLOBIN 3+
- ▶ WHITE BLOOD CELLS 442 cmm
- ▶ RED BLOOD CELLS 830 cmm
- ▶ CAST NIL
- ▶ CRYSTAL NIL
- ▶ OTHERS BACTERIA ++
- ▶ SPECIFIC GRAVITY 1.025

Lower Urinary tract infection

29 years old male c.o fever, chills, Rt flank pain and dysuria

- ▶ NITRITE negative
- ▶ leukocyte esterase..... Positive
- ▶ PH 8.1
- ▶ PROTEIN 1+
- ▶ GLUCOSE NIL
- ▶ KETONE TRACE
- ▶ BLOOD 3+
- ▶ HEMOGLOBIN 3+
- ▶ WHITE BLOOD CELLS 512 cmm
- ▶ RED BLOOD CELLS 671 cmm
- ▶ RBC CAST NIL
- ▶ WBC CAST Positive
- ▶ OTHERS BACTERIA ++
- ▶ SPECIFIC GRAVITY 1.025

Acute pyelonephritis
(upper urinary tract
infection)

45 years old gentleman c.o facial swelling in the morning and lower limb swelling

The following urine analysis is shown below.

NITRITE	negative
PH	5.8
PROTEIN	4+
WBC	10 / CMM
RBC	10 / CMM
CASTS	NIL
ANTIBACTERIAL ACTIVITY	NIL
HEMOGLOBIN	NIL
CULTURE	NO GROWTH

Heavy Proteinuria
most likely nephrotic syndrome

To Confirme it we need 24 urine collection
If > 3.5 g/day.

CBC (quick review)

- ▶ Safe CBC interpretation
- ▶ How to Approach to Anemia
- ▶ What is the Hb level indicating blood transfusion?
- ▶ How to distinguish IDA from Thalassemia?
- ▶ what is DDX of normocytic and macrocytic anemia?
- ▶ What finding suggest hemolytic anemia and what laboratory orders can confirm it?
- ▶ How to distinguish primary Vs secondary polycythemia
- ▶ At what level spontaneous bleeding risk is very high in thrombocytopenic patient?
- ▶ What are the main two types Thrombocytosis?
- ▶ what medical emergency can occur in Neutropenic patient?.
- ▶ What is the main three DDX of Pancytopenia?

Urine (quick review)

- ▶ How to assess kidney function?
- ▶ What are the urine analysis findings in UTI?
- ▶ What is the urine analysis finding indicating Pyelonephritis?
- ▶ What is the lowest abnormal value for RBC in microscopic urine analysis?
- ▶ At what level of protein nephrotic range start to be diagnosed?



Thank you