Myeloproliferative Neoplasms

An evolving full blood count.

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Session Aims

01

MPN 101

Overview of the disorder and its classifications.

02

FBC at Presentation

How we diagnose FBC, and how the full blood appears.

03

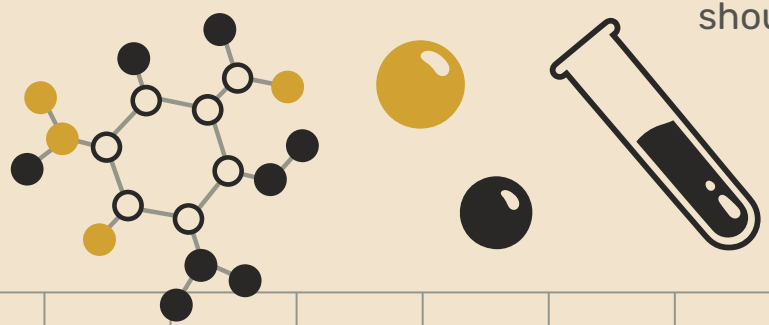
FBC and Treatment

Available treatments, and the changes they cause.

04

FBC and Transformation

How the disorders can transform, and wether that should concern us!!



Acronyms

MPN	Myeloproliferative Neoplasm
MPD	Myeloproliferative Disease
PRV	Polycythaemia Rubra Vera
PV	Polycythaemia Vera
ET	Essential Thrombocythemia
HU	Hydroxyurea
HC	Hydroxycarbamide
PMF	Primary Myelofibrosis

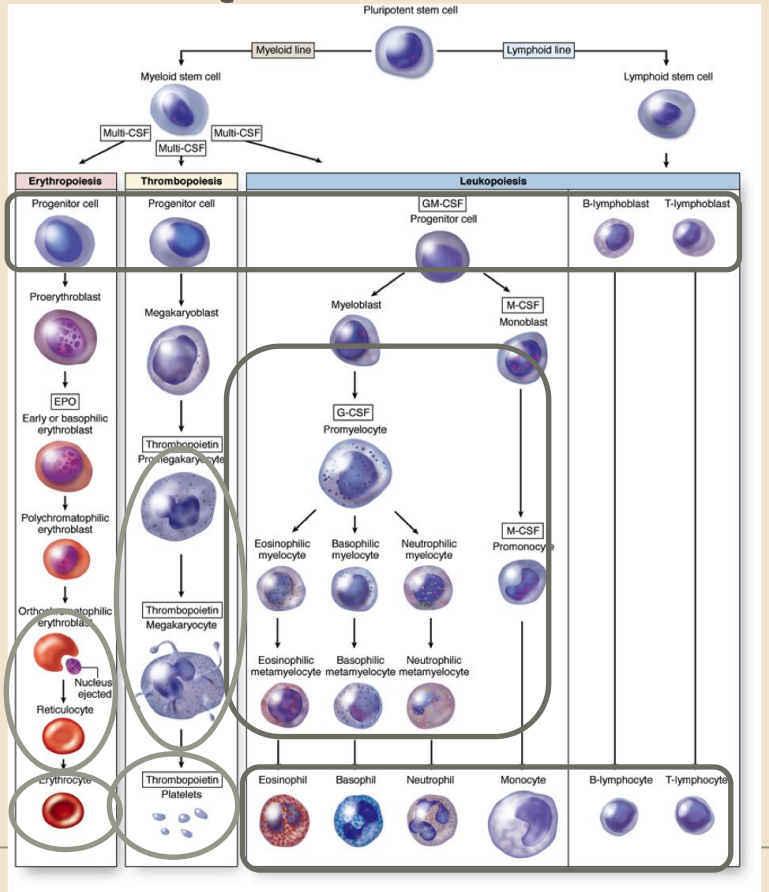
Haematopoiesis Revision

All blood cells are made in the bone marrow, but only a few enter into peripheral blood (PB).

Megakaryocytes are extremely uncommon in PB.

Red cell precursors are common in anaemia

These cells are normal in peripheral blood.



Blasts are always concerning in peripheral blood!

Myeloid precursors can be present in PB for many reasons- not all are malignant!

In MPDs, there is an increase in normal, mature cells.

What is an MPD?

What?

- Chronic myeloid disorder.
- Associated with production of normal cells in excess.

Who?

- Can affect any age.
- Many patients can expect to have a normal lifespan

Types

- Polycythaemia Vera
- Essential Thrombocythemia
- Primary Myelofibrosis
- Chronic Myeloid Leukaemia
- Chronic Neutrophilic Leukaemia
- Chronic Eosinophilic Leukaemia

Our focus today is on these 3 disorders.

PV/ET/PMF/CML

Features	PV	ET	PMF
Associated mutation	*JAK2*	*JAK2/CALR/MPL*	*JAK2/CALR/MPL*
Affect on FBC	↑Hb, ↑Hct, ↑RBCC	↑Plts	↓RBCC, ↓WBCC, ↓Plts
Diagnostic Criteria	• Male Hct: >0.52 • Female Hct: >0.48	• Plts >600x10^9/L • No reactive cause	• Bone marrow fibrosis • Leucoerythroblastic blood film

The Mutations are not essential, you can be diagnosed with triple negative PV/ET/PMF!

FBC at Presentation

05/11/2020 u/k Blood

Request Reason : Hb monitoring.

HB	193	g/L	(130 to 170)	Auth
WBC	7.2	10*9/L	(4.0 to 11.0)	Auth
PLT	398	10*9/L	(150 to 410)	Auth
RBC	6.15	10*12/L	(4.50 to 5.50)	Auth
HCT	0.578	L/L	(0.400 to 0.500)	Auth
MCV	93.9	fL	(83 to 101)	Auth
MCH	31.4	pg		
MCHC	334	g/		
RDW	16.1			
MPV	9.4	fL		
Neutrophils	5.1	10		
Lymphocytes	1.3	10		
Monocytes	0.6	10		

22/12/2022 08:40 Blood

Request Reason : persistent raised platelets.

HB	127	g/L	(120 to 150)	Auth
WBC	7.6	10*9/L	(4.0 to 11.0)	Auth
PLT	639	10*9/L	(150 to 410)	Auth
RBC	4.25	10*12/L	(3.80 to 4.80)	Auth
HCT	0.377	L/L	(0.360 to 0.460)	Auth
MCV	88.6	fL	(83 to 101)	Auth
MCH	29.9	pg	(27.0 to 32.0)	Auth
MCHC	337	g/L	(315 to 345)	Auth
RDW	13.0		(11.6 to 14.0)	Auth
MPV	7.2	fL	(7.5 to 11.2)	Auth
Neutrophils	3.2	10*9/L	(2.0 to 7.0)	Auth
Lymphocytes	3.6	10*9/L	(1.0 to 3.0)	Auth
Monocytes	0.5	10*9/L	(0.2 to 1.0)	Auth

FBC at Presentation

09/01/2023 08:02 Blood
Request Reason : MF.

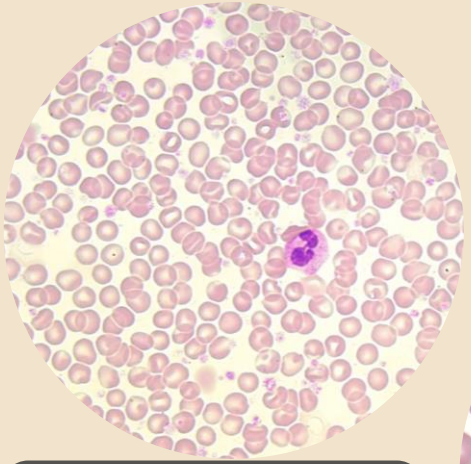
HB	88	g/L	(130 to 170)	Auth
WBC	2.6	10*9/L	(4.0 to 11.0)	Auth
PLT	14	10*9/L	(150 to 410)	Auth
RBC	3.05	10*12/L	(4.50 to 5.50)	Auth
HCT	0.254	L/L	(0.400 to 0.500)	Auth
MCV	83.1	fL	(83 to 101)	Auth
MCH	28.9	pg	(27.0 to 32.0)	Auth
MCHC	348			
RDW	16.6			
MPV	9.3			
Neutrophils	0.8			
Lymphocytes	1.3			
Monocytes	0.4			

1 Spec 2 Patient 3 Date 4 pRint 5

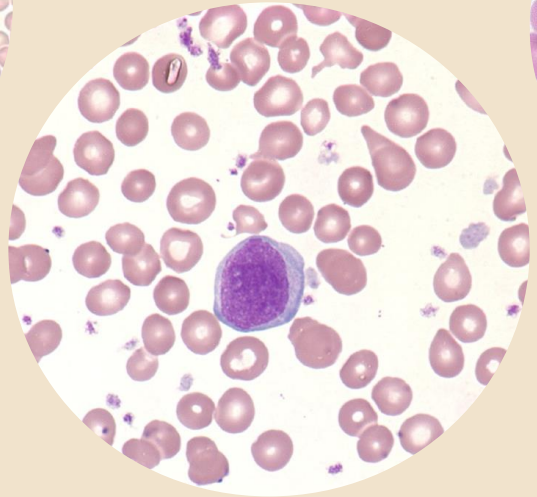
10/01/2023 07:14 Blood
Request Reason : monitoring.

HB	122	g/L	(130 to 170)	Auth
WBC	21.0	10*9/L	(4.0 to 11.0)	Auth
PLT	1018	10*9/L	(150 to 410)	Auth
RBC	5.22	10*12/L	(4.50 to 5.50)	Auth
HCT	0.403	L/L	(0.400 to 0.500)	Auth
MCV	77.2	fL	(83 to 101)	Auth
MCH	23.4	pg	(27.0 to 32.0)	Auth
MCHC	303	g/L	(315 to 345)	Auth
RDW	21.6		(11.6 to 14.0)	Auth
MPV	7.7	fL	(7.5 to 11.2)	Auth
Neutrophils	20.3	10*9/L	(2.0 to 7.0)	Auth
Lymphocytes	0.2	10*9/L	(1.0 to 3.0)	Auth
Monocytes	0.5	10*9/L	(0.2 to 1.0)	Auth

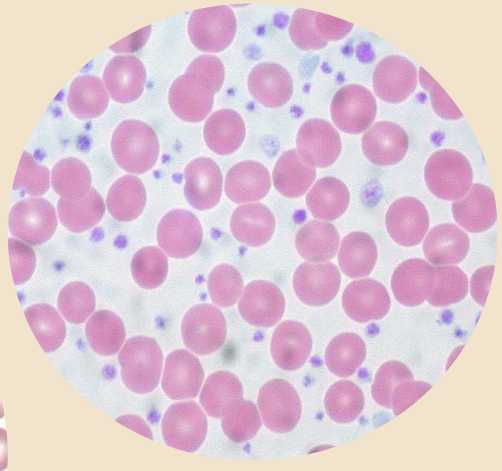
Blood Film Features



Polycythaemia Vera



Primary Myelofibrosis



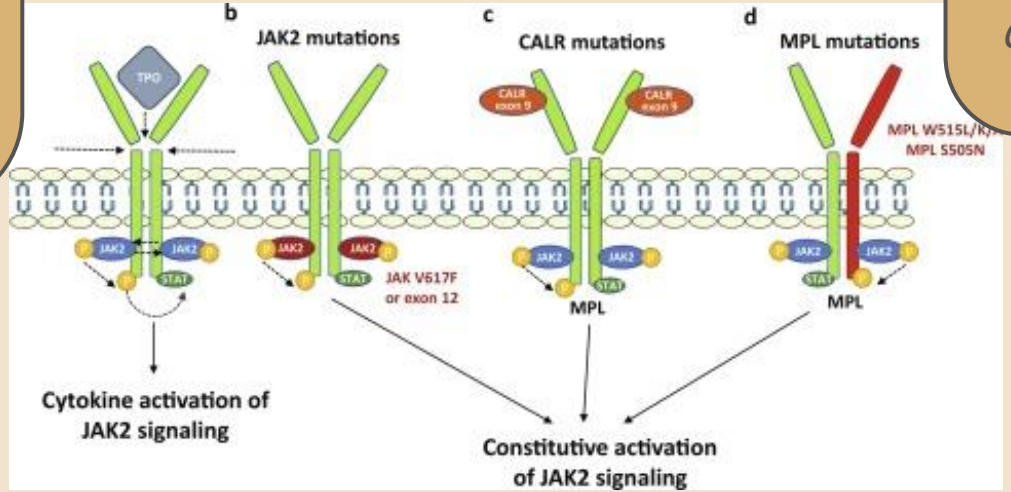
Essential Thrombocythemia

The Differential Diagnosis

	PV	ET	PMF
Secondary Causes	Smoking/Hypoxia	Infection	Can appear similar to patients treated with GCSF, or those with CML.
	Obesity	Iron Deficiency	
	Dehydration	Inflammation	Marrow infiltration by metastatic cancer.
	Testosterone Abuse	Hyposplenism	
	Alcoholism	Bleeding	

Pathophysiology and Genetics

Mutations to *JAK2, MPL, CALR* are diagnostic and distinguish MPDs from secondary causes.



JAK2 mutations can occur in all 3, but *CALR* and *MPL* do NOT occur in PV.

The end product of all 3 is a loss of regulation in production- normal cells are being made, they just don't know when to stop!

Treatment Options

Treatments	PV	ET	PMF
Aspirin	✓	✓	✓
Hydroxycarbamide	✓	✓	✓
Venesection	✓	✗	✗
Other available drugs.	Interferon-Alpha Ruxolitinib	Anagrelide Busulfan	Cladribine Interferon-Alpha Thalidomide

Affects of Treatment

Treatments	Affect
Aspirin	• Reduces thrombotic risk. • Dysregulation of platelet function.
Hydroxycarbamide	• Reduces cell burden. • Interferes with the production of DNA. • Causes megaloblastic anaemia. • Can result in cytopenia's.
Venesection	• Reduced red cell burden. • Can result in iron restriction (pseudo-iron deficiency)

There are several other drugs available, including ruxolitinib, anagrelide, busulfan etc. These drugs can cause cytopenia's, but other side effects tend to be clinical!

FBC and Treatment

Clinical Info: NHS Number: 450 714 1486 Tel:
ET. Date received: 10/01/2023 R
Specimen No : HQ847085X Haematology <PgUp> for earlier

10/01/2023 08:56 Blood
Request Reason : ET.

HB	137	g/L		
WBC	6.0	10*		
PLT	408	10*		
RBC	3.65	10*		
HCT	0.408	L/L		
MCV				
MCH				
MCHC				
RDW				
MPV				
Neut				
Lymp				
Monc				

05/01/2017 11:05 Blood
Request Reason : memory.

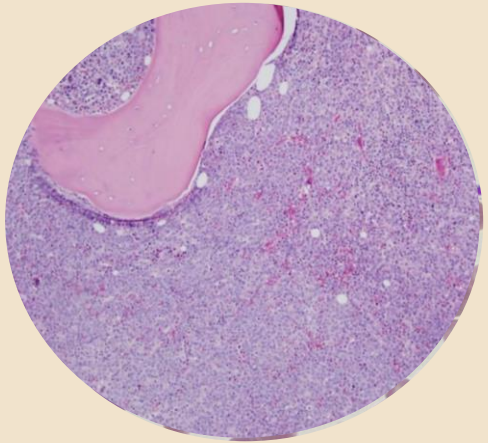
HB	143	g/L	(120 to 160)	Auth
WBC	10.8	10*9/L	(4.0 to 11.0)	Auth
PLT	630	10*9/L	(150 to 400)	Auth
			(3.80 to 5.80)	Auth
			(0.350 to 0.450)	Auth
			(80 to 100)	Auth
			(27.0 to 32.0)	Auth
			(300 to 358)	Auth
			(11.0 to 14.5)	Auth
			(6.5 to 20.0)	Auth
			(2.0 to 7.5)	Auth
			(1.5 to 4.0)	Auth
			(0.2 to 0.8)	Auth

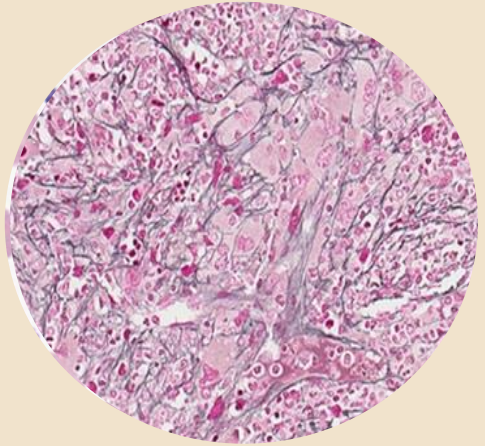
19/10/2021 10:20 Blood
Request Reason : ET on hydroxycarbamide.

HB	102	g/L	(120 to 150)	Auth
WBC	2.0	10*9/L	(4.0 to 11.0)	Auth
PLT	538	10*9/L	(150 to 410)	Auth
RBC	2.48	10*12/L	(3.80 to 4.80)	Auth
HCT	0.302	L/L	(0.360 to 0.460)	Auth
MCV	122.1	fL	(83 to 101)	Auth
MCH	41.2	pg	(27.0 to 32.0)	Auth
MCHC	337	g/L	(315 to 345)	Auth
RDW	15.5		(11.6 to 14.0)	Auth
MPV	8.1	fL	(7.5 to 11.2)	Auth
Neutrophils	1.1	10*9/L	(2.0 to 7.0)	Auth
Lymphocytes	0.7	10*9/L	(1.0 to 3.0)	Auth
Monocytes	0.1	10*9/L	(0.2 to 1.0)	Auth

Transformation

Transformation	PV	ET	PMF
Myelofibrosis	✓	✓	✗
Acute Myeloid Leukaemia	✓	✓	✓





FBC and Transformation

15/03/2022 10:25 Blood

Request Reason : Polycythaemia, on Ruxolitinib. Pre-Haem clinic blood test.

HB	111	g/L	(120 to 150)	Auth
WBC	19.7	10*9/L	(4.0 to 11.0)	Auth
PLT	434	10*9/L	(150 to 410)	Auth
RBC	3.35	10*12/L	(3.80 to 4.80)	Auth
HCT	0.342	L/L	(0.360 to 0.460)	Auth
MCV	102.0	fL	(83 to 101)	Auth
MCH	33.1	pg	(27.0 to 32.0)	Auth
MCHC	324	g/L	(315 to 345)	Auth
RDW	20.2		(11.6 to 14.0)	Auth
MPV	9.5	fL	(7.5 to 11.2)	Auth
Neutrophils	^12.1	10*9/L	(2.0 to 7.0)	Auth
Neutrophils.....	11.4	10*9/L	(2.0 to 7.0)	Auth
Lymphocytes	^3.8	10*9/L	(1.0 to 3.0)	Auth
Lymphocytes.....	3.2	10*9/L	(1.0 to 3.0)	Auth
Monocytes	^2.6	10*9/L	(0.2 to 1.0)	Auth
Monocytes.....	2.6	10*9/L	(0.2 to 1.0)	Auth
Eosinophils	^0.6	10*9/L	(0.00 to 0.5)	Auth
Eosinophils.....	0.8	10*9/L	(0.00 to 0.5)	Auth
BAS	^0.6	10*9/L	(0.0 to 0.1)	Auth
Basophils.....	0.4	10*9/L	(0.0 to 0.1)	Auth
Band Forms.....	0.4	10*9/L		Auth
Myelocytes.....	0.6	10*9/L		Auth
Blasts.....	0.4	10*9/L	(0.0 to 0.0)	Auth
Automated Nucleated Red Count	^0.3	10*9/L	(0.0 to 0.1)	Auth

Polycythaemia Vera transforming to Myelofibrosis.

Counts may not change, or they may develop cytopenia's.

Clinical progression may be more evident, including splenomegaly.

FBC and Transformation

13/10/2022 10:10 Blood
Request Reason : MF.

HB	67	g/L	(130 to 170)	Auth
WBC	16.6	10*9/L	(4.0 to 11.0)	Auth
PLT	13	10*9/L	(150 to 410)	Auth
RBC	2.35	10*12/L	(4.50 to 5.50)	Auth
HCT	0.199	L/L	(0.400 to 0.500)	Auth
MCV	85.0	fL	(83 to 101)	Auth
MCH	28.7	pg	(27.0 to 32.0)	Auth
MCHC	338	g/L	(315 to 345)	Auth
RDW	16.8		(11.6 to 14.0)	Auth
MPV	8.9	fL	(7.5 to 11.2)	Auth
Neutrophils	^1.3	10*9/L	(2.0 to 7.0)	Auth
Neutrophils.....	4.5	10*9/L	(2.0 to 7.0)	Auth
Lymphocytes	^0.9	10*9/L	(1.0 to 3.0)	Auth
Lymphocytes.....	2.2	10*9/L	(1.0 to 3.0)	Auth
Monocytes	^14.4	10*9/L	(0.2 to 1.0)	Auth
Monocytes.....	1.3	10*9/L	(0.2 to 1.0)	Auth
Eosinophils	^0.0	10*9/L	(0.00 to 0.5)	Auth
Eosinophils.....	0.0	10*9/L	(0.00 to 0.5)	Auth
BAS	^0.0	10*9/L	(0.0 to 0.1)	Auth
Basophils.....	0.0	10*9/L	(0.0 to 0.1)	Auth
Band Forms.....	0.0	10*9/L		Auth
Myelocytes.....	0.2	10*9/L		Auth
Promyelocytes.....	0.0	10*9/L		Auth
Blasts.....	8.5	10*9/L	(0.0 to 0.0)	Auth
Atypical Cells.....	0.0	10*9/L		Auth
Automated Nucleated Red Count	^0.0	10*9/L	(0.0 to 0.1)	Auth

Myelofibrosis transforming to Acute Myeloid Leukaemia.

Cytopenia's common as the marrow is busy making blasts.

Unlike MF, blasts will form a significant component of the cells.

When should we act?

First Prese
any MPD.

penia's on a
nown MPD

New blast fl
leucocytosis
known MPD

Significant
s in counts
own patient
e.g. doubling

Macrocytosis for patients with known MPD (likely HC treatment), or stable counts, even if the counts are abnormal, can be authorised!

Thanks!

Do you have any questions?

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