Interpretive comments in CBC reports

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Introduction

- Lab professionals can contribute to the test result interpretation ☞ to provide other healthcare professionals a better understanding of the obtained results.

Introduction

- There has been tremendous improvement in the Lab processes in the past years including:
  - preanalytical processes (such as barcoding of primary samples, electronic orders, automatic check for clots, lipemia, hemolysis and icterus),
  - analytical processes (use of automated advanced assay platforms with low intra assay and inter assay variation)
  - post analytical processes (such as auto validation and connection of hospitals with laboratory information system).
- Together with all these improvements, the role of Lab physician has changed which includes interaction with both clinicians and patients apart from technical chores.
  - Clinical interpretation of obtained test result however depends on extensive practical and theoretical clinical expertise of the Lab physician.

Introduction

- Although there are no universal guidelines regarding the use of interpretative comments (IC) ☞ the ISO 15189 standard in its clause 5.8.3 states that the Lab report should include IC where appropriate.
- Correct interpretation of Lab results is crucial for accurate and timely diagnosis and appropriate management of clinical condition.
- IC establish a positive relationship between the Lab and the clinic, and it:
  1. reduces time to diagnosis,
  2. prevents misdiagnosis and
  3. reduces the number of irrelevant laboratory tests.

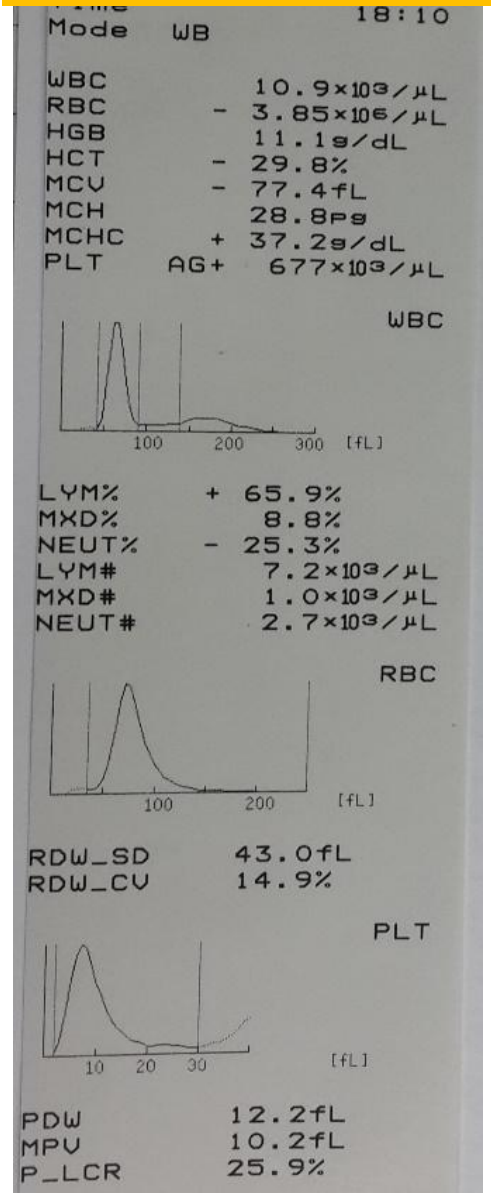
Introduction

- Interpretative comments associated with laboratory results are a means of **communication** between Lab, patients and requesting physicians.
- These comments are intended to:
  1. clarify some interpretative aspects
  2. and to suggest diagnostic implications.
- In most uses, comments are a kind of diagnostic complement in increasing the significance and clinical application of different results that are linked by physiopathological interrelationships.
- So, interpretative comments ☞ qualify and improve in the **post-analytical phase** the professional quality of the clinical laboratory.

Complete Blood Count (CBC)

- CBC is the primary diagnostic tool for an all-encompassing study of the “blood organ” which is involved, among other things, in:
  (i) the oxygen transport and its utilization,
  (ii) the non-specific and specific immunity and
  (iii) the coagulative system.
- This fact is made possible by the "multiparametric" structure of the CBC which, in the results provided by the main hematological analyzers, contains more than 40 numerical results.
  - Of these, only about 30 are “reportable parameters”.
- Besides, the microscopic review of PBS (peripheral blood smears) in samples with abnormal CBC **adds** further qualitative diagnostic information which gives the complete hematological report a considerable complexity.
- For these reasons, the hematologic diagnosis must be adequately assessed in all possible aspects of the interpretation, more than other diagnostic areas probably.

Elevated MCHC



45 years old female

Elevated MCHC
>36 g/dL

Abnormal RBC

- Spherocytosis[1]
- Sickle cells[1]
- Hemoglobin C[1]
- Xerocytosis[1]
- RBC agglutination[2]

Abnormal Plasma

- Hyperlipidemia[3]
- Hemolysis (i.e., free hemoglobin)[4]

[1]These conditions may increase the MCHC as the smaller RBCs result in a 'relatively' high concentration of hemoglobin.

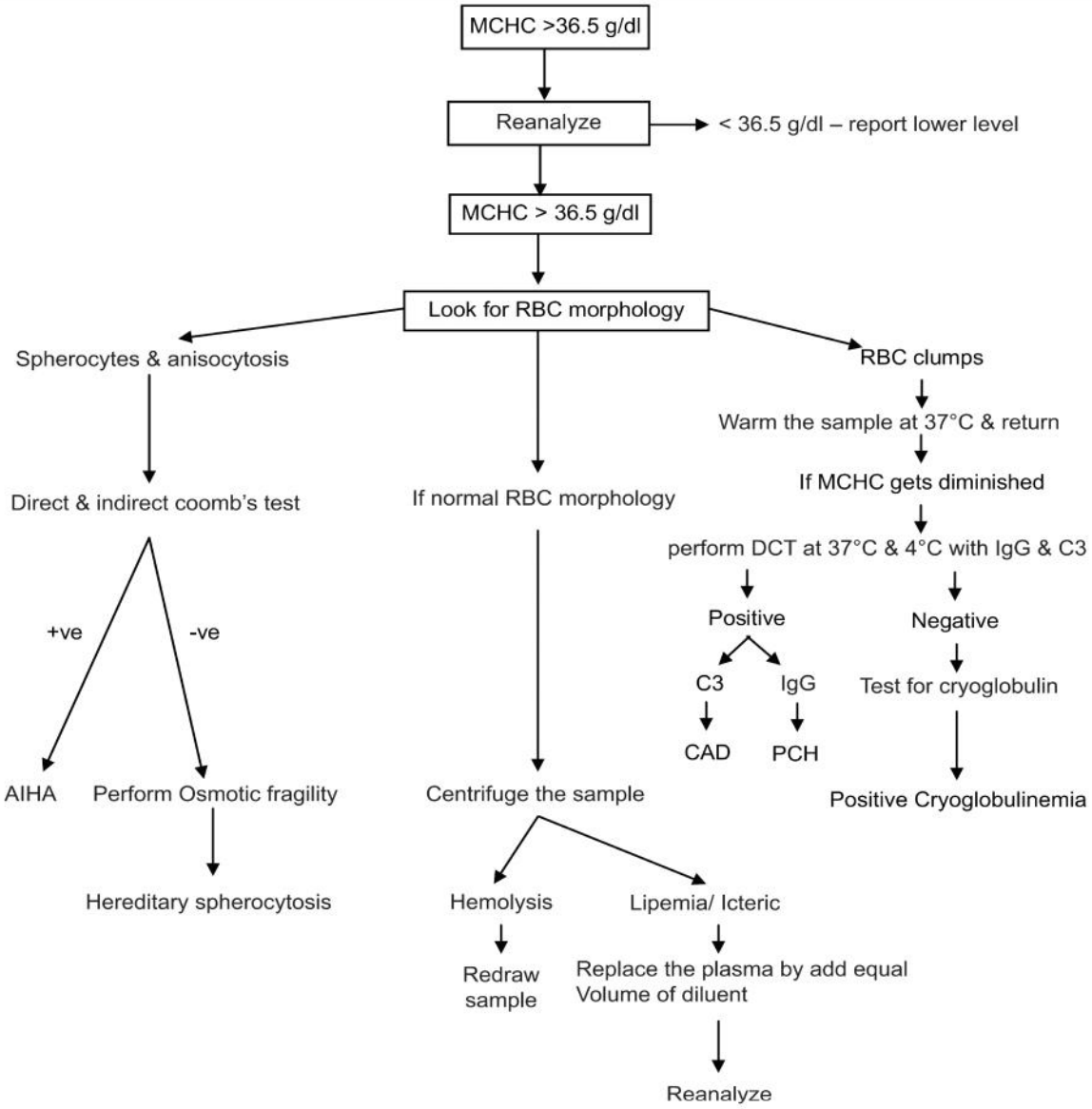
[2]Cold agglutination can cause RBC clumping, which falsely lowers the RBC count. Given that the MCHC is calculated using the RBC count and hemoglobin (which is unaffected), the MCHC is elevated.

[3]Lipemia may increase the automated MCHC as the optical interference alters the measured hemoglobin level.

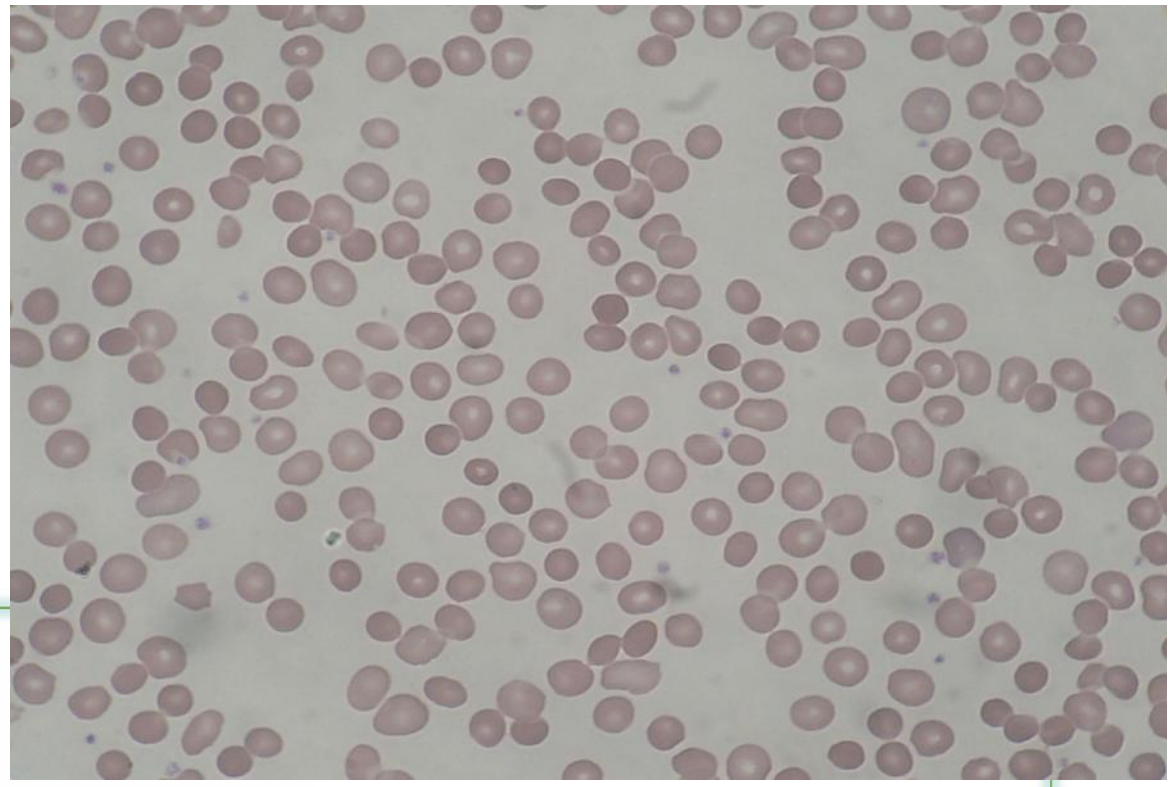
[4]In hemolysis, the RBC count decreases. The free plasma hemoglobin may be picked up, falsely elevated the hemoglobin, leading to an elevated MCHC.

$$MCHC = \frac{Hgb}{MCV \times RBC}$$

Elevated MCHC



Spherocytosis



Interpretive Comment:

- Peripheral blood demonstrates spherocytosis.
- Suggest hemolytic investigation including reticulocyte count, haptoglobin, bilirubin, and LD.
- A direct antiglobulin test (DAT) should be performed to look for evidence of immune-mediated hemolysis. If DAT is negative, osmotic fragility test (OFT) or flow cytometry evaluation for hereditary spherocytosis is recommended.
- Hemolytic transfusion reaction should be considered.

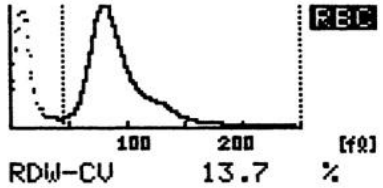
RBC agglutination

DATE: 83/ 1/25 18:42
MODE: WHOLE BLOOD

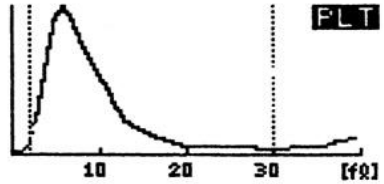
WBC	WL+	17.4×10³	/μl
RBC	-	1.06×10⁶	/μl
HGB	-	8.6	g/dl
HCT	-	10.2	%
MCV		96.2	fl
MCH	+	81.1	pg
MCHC	+	84.3	g/dl
PLT		331×10³	/μl

59 years old female

LYMPH%	WL	---.-	%
MXD %	WL	---.-	%
NEUT%	WL	---.-	%
LYMPH#	WL	---.-	×10³/μl
MXD #	WL	---.-	×10³/μl
NEUT#	WL	---.-	×10³/μl

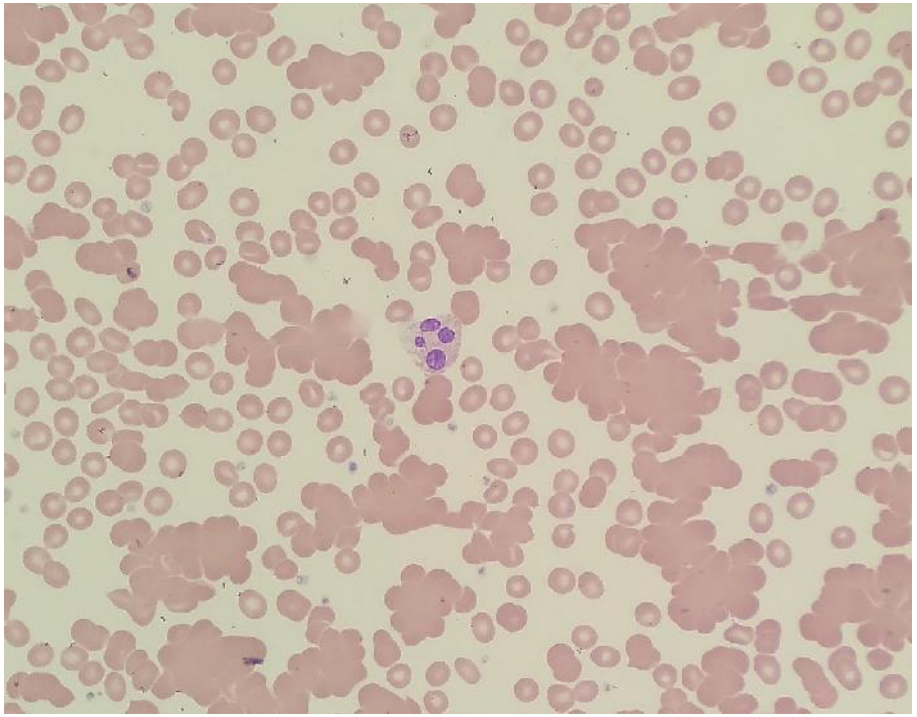


RDW-CV 13.7 %



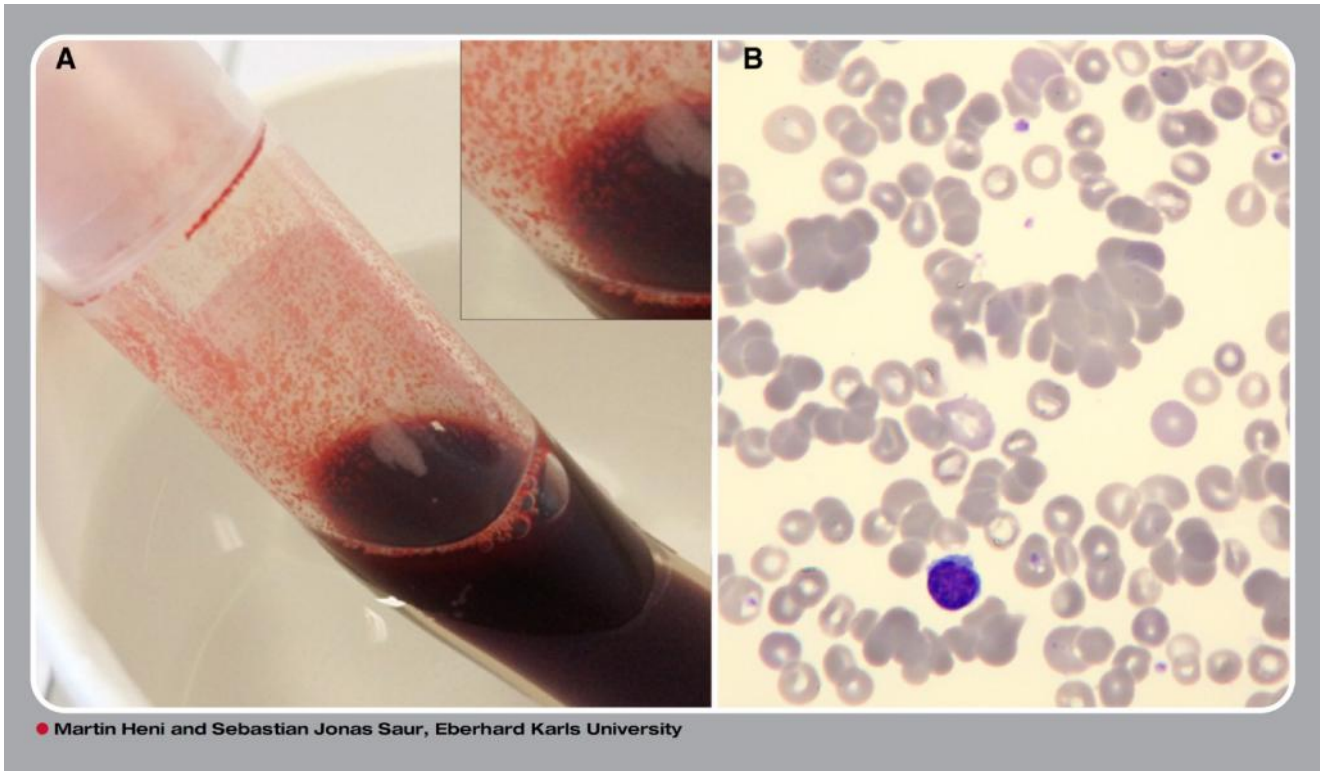
PDW	10.7	fl
MPV	9.3	fl
P-LCR	21.1	%

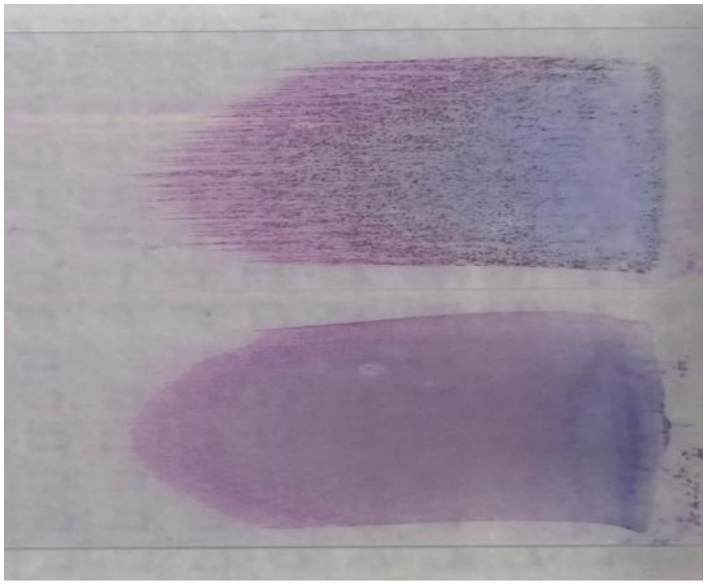
- Cold agglutinins: generally cause RBC clumping → interferes with RBC-associated CBC parameters and **yields**:
  1. falsely ↓ RBC count and Hct
  2. falsely ↑ MCV, MCH, and MCHC.
  3. Sometimes, falsely ↓ WBC count ☞ WBCs may get trapped in the RBC agglutinates.



RBC agglutinins (RBC agglutination)

- RBC agglutination:
  1. may be visually evident on the interior wall of the specimen tube.
  2. is generally noted upon microscopic exam of PBS.

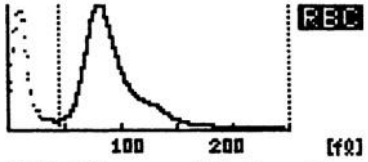




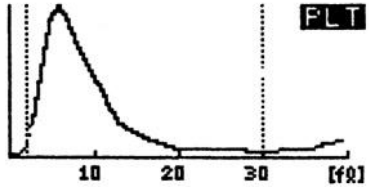
No. 5
DATE: 83/ 1/25 18:42
MODE: WHOLE BLOOD

WBC	WL+	17.4×10³	/μl
RBC	-	1.06×10⁶	/μl
HGB	-	8.6	g/dl
HCT	-	10.2	%
MCV		96.2	fl
MCH	+	81.1	pg
MCHC	+	84.3	g/dl
PLT		331×10³	/μl

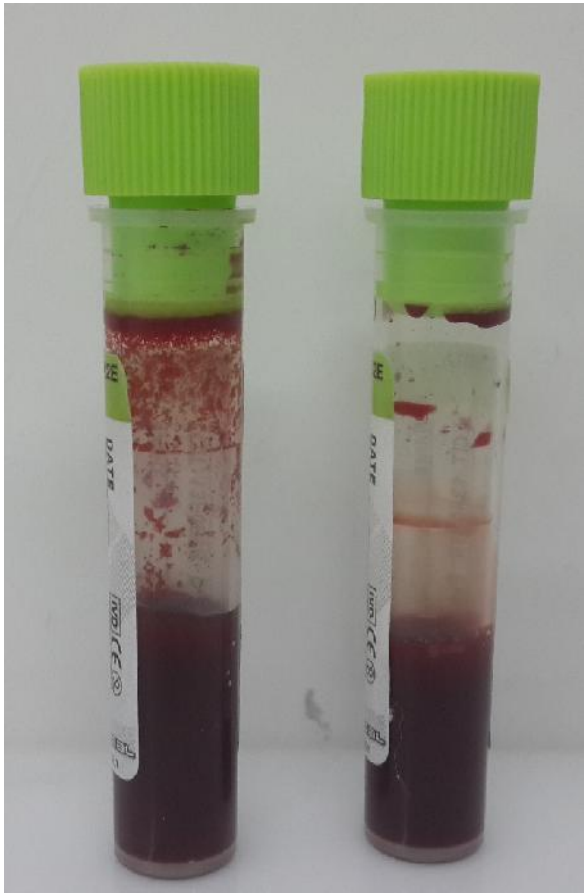
LYMPH%	WL	---.-	%
MXD %	WL	---.-	%
NEUT%	WL	---.-	%
LYMPH#	WL	---.-×10³	/μl
MXD #	WL	---.-×10³	/μl
NEUT#	WL	---.-×10³	/μl

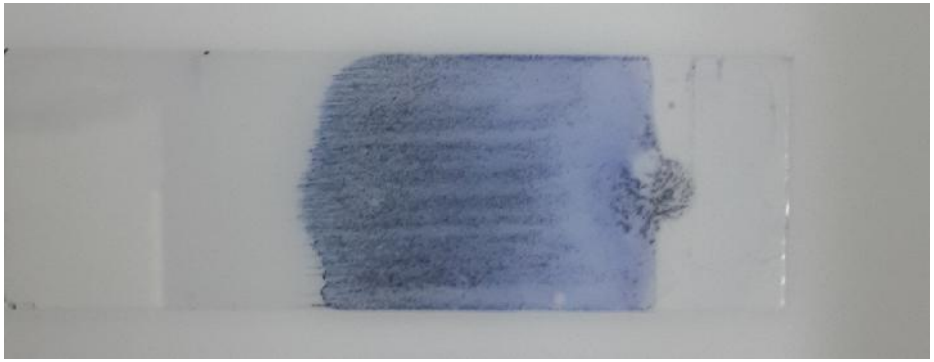


RDW-CV	13.7	%



PDW	10.7	fl
MPV	9.3	fl
P-LCR	21.1	%





RBC agglutinins (RBC agglutination)

- **To obtain reliable results:**
  1. a common practice: incubate specimen at 37°C (10–15 min) ☞ and immediately rerun the analysis.
     - ✓ this approach generally **yields accurate results** of all CBC parameters.
     - ✓ a PBS made after incubation ☞ should be examined to confirm the absence of RBC agglutination.
  2. if the above approach fails to yield accurate results ☞ request a new specimen to be collected & maintained at 37°C until analyzed.

Results of initial run	
WBC ($\times 10^3$/μL)	5.4
RBC ($\times 10^6$/μL)	1.88
Hb (g/dL)	11.7
Hct (%)	19.8
MCV (fL)	105.3
MCH (pg)	62.2
MCHC (g/dL)	59.1
RDW (%)	000*
PLT (10^3/μL)	328

Helpful indicator(s): elevated MCH and MCHC, and all "three rules of three" (Hct and Hb, Hb and RBC, and RBC and Hb) failed

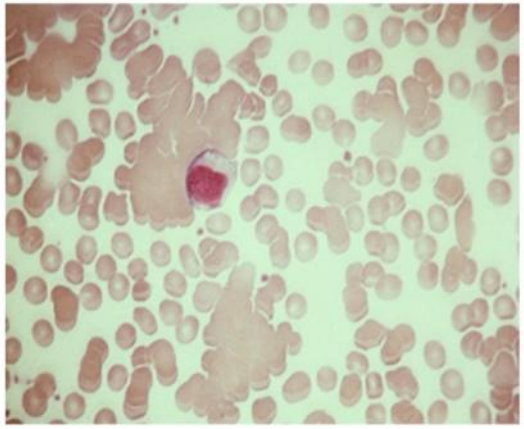
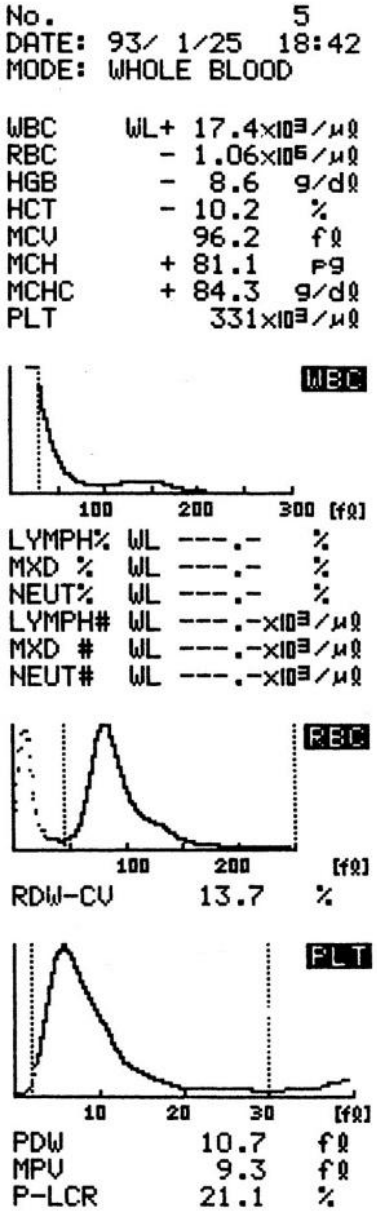
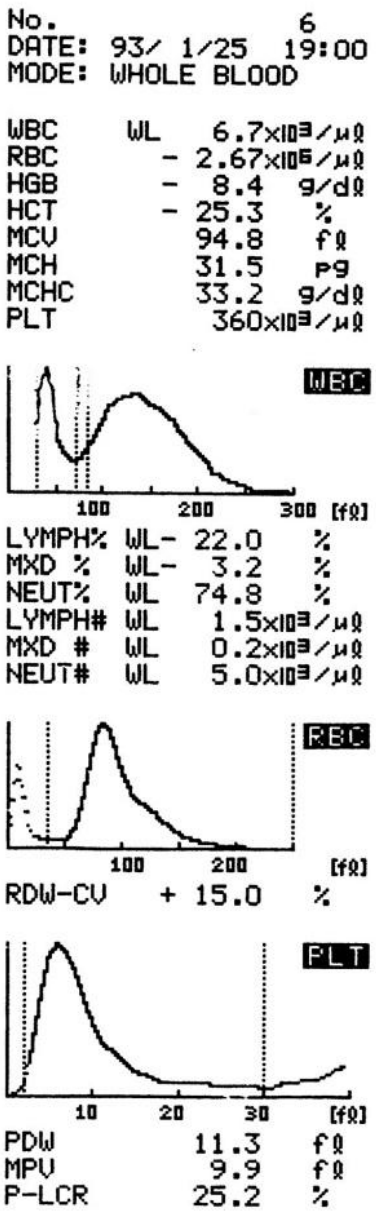


Fig. 2. Blood smear (Wright–Giemsa, ×1,000) revealing RBC agglutination.

Results of rerun after incubation at 37°C	
WBC ($\times 10^3$/μL)	7.3
RBC ($\times 10^6$/μL)	3.90
Hb (g/dL)	12.1
Hct (%)	36.5
MCV (fL)	94.0
MCH (pg)	31.0
MCHC (g/dL)	33.2
RDW (%)	14.2
PLT (10^3/μL)	298

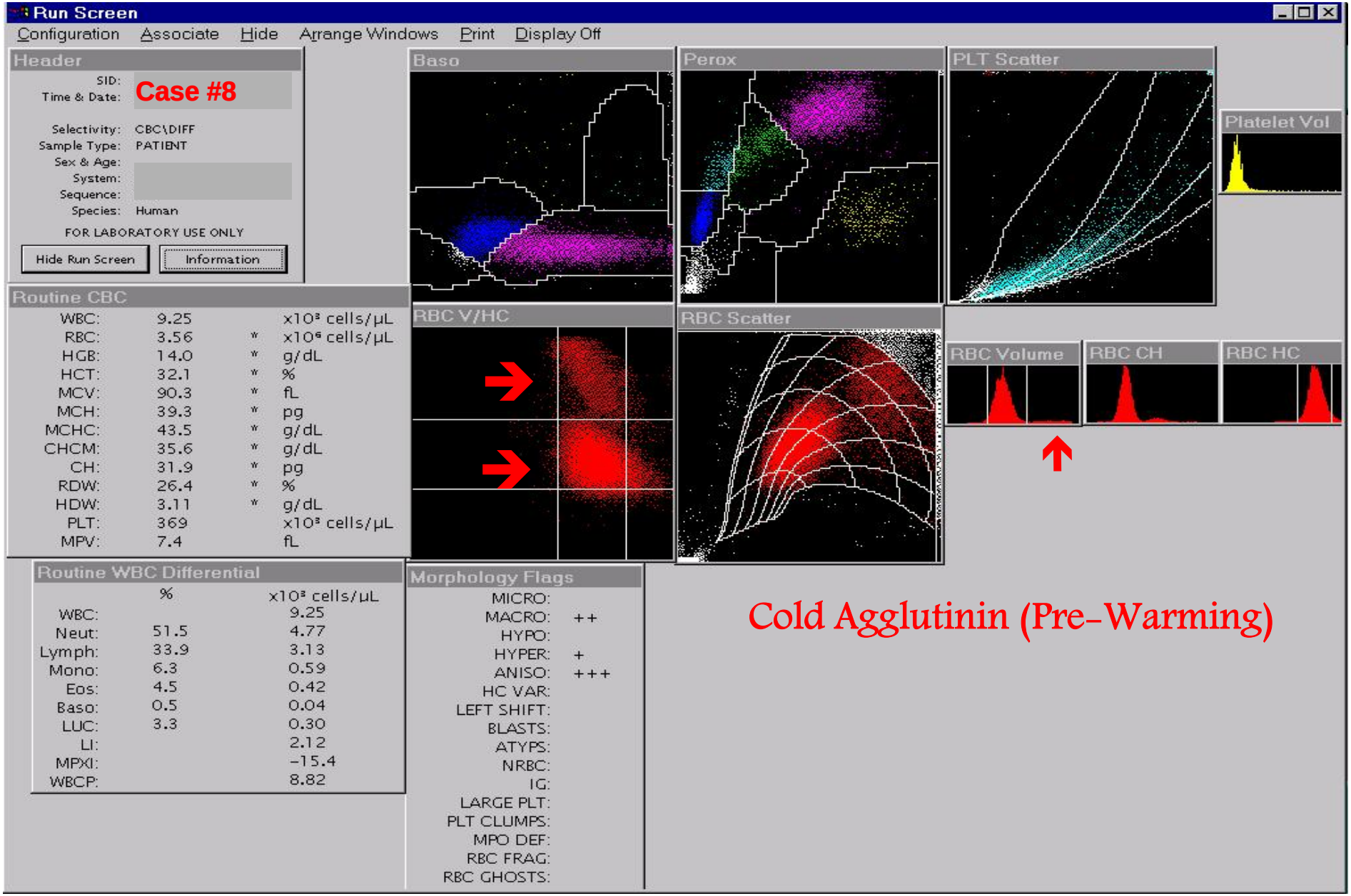




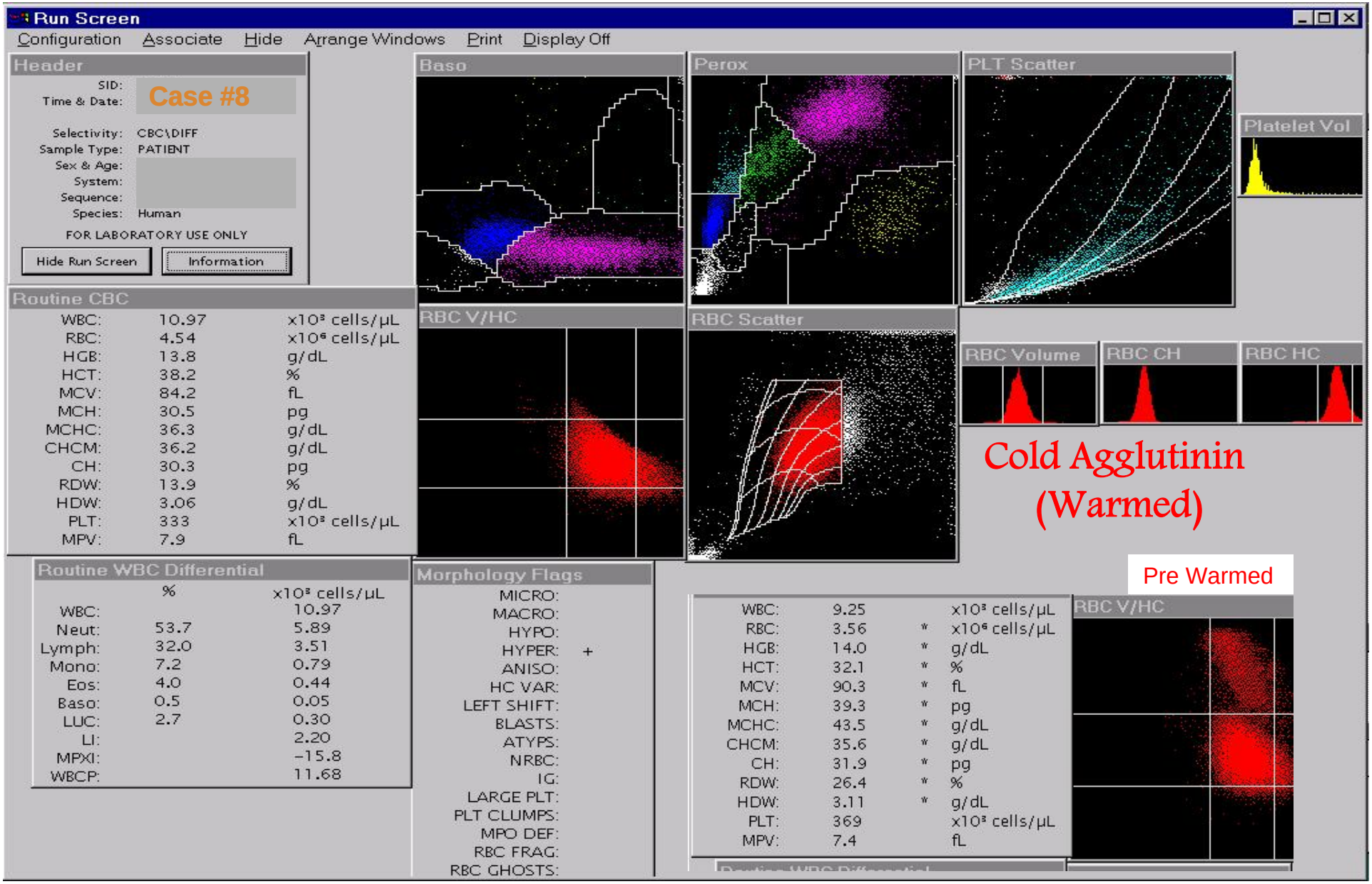
- A 59-year-old woman with symptoms of anemia, shortness of breath, fatigue, lethargy, and weakness was referred.
  - Leukocytosis, anemia and irrational RBC indices and hematocrit were observed in routine tests.
  - Lack of diff count of WBCs, abnormal WBC histogram, as well as multiple flags were found in patient's CBC.
  - RBC masses were attached to the wall of tubes.
  - In the PBS, several masses of agglutination were seen.
  - The patient's sample was incubated at 37°C for 30 minutes and after that, it was immediately analyzed. ☞ significant changes were observed in CBC parameters.

Interpretive Comment:

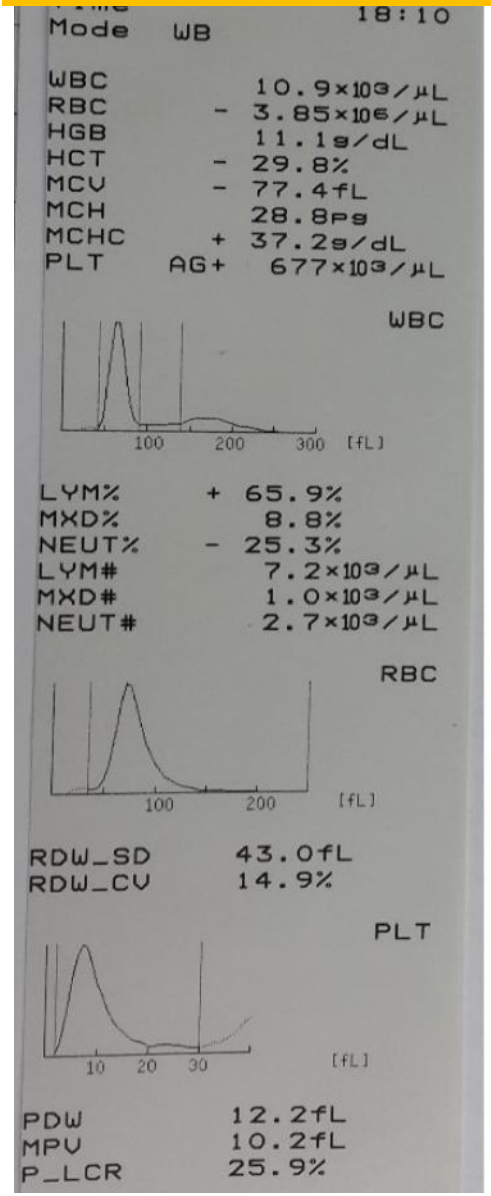
- Peripheral blood film demonstrates red blood cell agglutination.
- Suggest hemolytic investigation including reticulocyte count, haptoglobin, bilirubin, and LD.
- A direct antiglobulin test should be performed to look for evidence of immune-mediated hemolysis, along with a cold agglutinin screen to assess the clinical relevance of this finding.



Cold Agglutinin (Pre-Warming)


Run Screen
Configuration
Associate
Hide
Arrange Windows
Print
Display Off
Header
SID:
Time & Date:
Case #8
Selectivity: CBC\DIFF
Sample Type: PATIENT
Sex & Age:
System:
Sequence:
Species: Human
FOR LABORATORY USE ONLY
Hide Run Screen
Information
Baso
Perox
PLT Scatter
Platelet Vol
Routine CBC
WBC: 10.97 x10³ cells/µL
RBC: 4.54 x10⁶ cells/µL
HGB: 13.8 g/dL
HCT: 38.2 %
MCV: 84.2 fL
MCH: 30.5 pg
MCHC: 36.3 g/dL
CHCM: 36.2 g/dL
CH: 30.3 pg
RDW: 13.9 %
HDW: 3.06 g/dL
PLT: 333 x10³ cells/µL
MPV: 7.9 fL
RBC V/HC
RBC Scatter
RBC Volume
RBC CH
RBC HC
Cold Agglutinin
(Warmed)
Routine WBC Differential
% x10³ cells/µL
WBC: 10.97
Neut: 53.7 5.89
Lymph: 32.0 3.51
Mono: 7.2 0.79
Eos: 4.0 0.44
Baso: 0.5 0.05
LUC: 2.7 0.30
LI: 2.20
MPXI: -15.8
WBCP: 11.68
Morphology Flags
MICRO:
MACRO:
HYPO:
HYPER: +
ANISO:
HC VAR:
LEFT SHIFT:
BLASTS:
ATYPS:
NRBC:
IG:
LARGE PLT:
PLT CLUMPS:
MPO DEF:
RBC FRAG:
RBC GHOSTS:
Pre Warmed
WBC: 9.25 x10³ cells/µL
RBC: 3.56 * x10⁶ cells/µL
HGB: 14.0 * g/dL
HCT: 32.1 * %
MCV: 90.3 * fL
MCH: 39.3 * pg
MCHC: 43.5 * g/dL
CHCM: 35.6 * g/dL
CH: 31.9 * pg
RDW: 26.4 * %
HDW: 3.11 * g/dL
PLT: 369 x10³ cells/µL
MPV: 7.4 fL
RBC V/HC

Lipemia interference



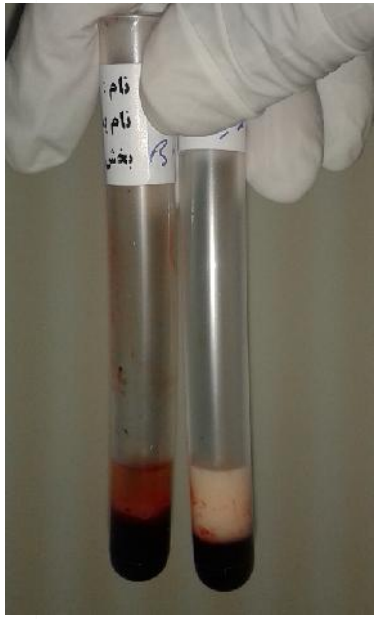
45 years old female

- Lipemia or hyperlipidemia: ↑ concentration of blood lipids (TGs; chylomicrons & VLDLs) ☞ is common in:
  1. postprandial specimens,
  2. in specimens drawn from patients with diabetes or
  3. those receiving parenteral nutrition with intralipid emulsion.

- interferes primarily with Hb measurement,
  - results in: falsely ↑ Hb, MCH, MCHC.

MCHC increased (> 36.5 g/dL *22. 7 mmol/L 365 g/L* **)**

Wrong RBC	Wrong HGB	Wrong MCV	True MCHC
Cold agglutinins	Haemolysis *(in vivo)*	Hypo-osmolarity	RBC disease *(e.g. spherocytosis)*
Haemolysis *(in vitro)*	Lipaemia	Cold agglutinins	
	Abnormal protein	Intra cellular dehydration	



Lipemia interference

- Lipemia or hyperlipidemia:
  1. A discrepancy between Hb / Hct, with ↑ MCHC ☞ is a useful indicator of lipemia.
  2. An analyzer flag of turbidity or Hb interference is also helpful.
  3. Lipemic blood appears milky turbid upon visual inspection of centrifuged specimen.

Results of initial run	
WBC ($\times 10^3$/μL)	4.7
RBC ($\times 10^6$/μL)	3.51
Hb (g/dL)	11.4
Hct (%)	29.1
MCV (fL)	81.5
MCH (pg)	33.3
MCHC (g/dL)	40.9
RDW (%)	16.8
PLT (10^3/μL)	53

Helpful indicators: elevated MCHC, Hct and Hb rule failed

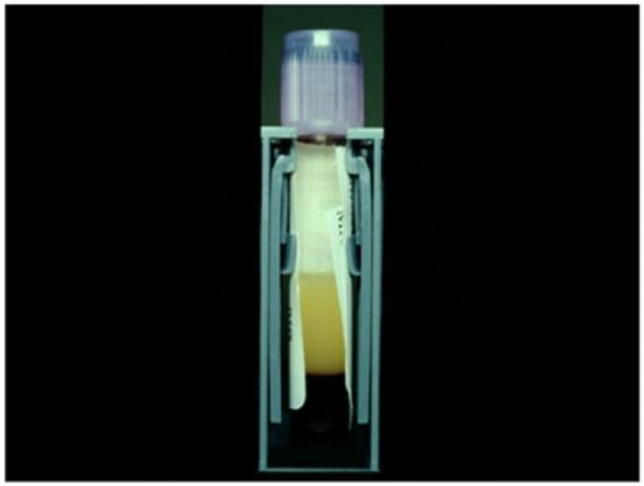


Fig. 1. Centrifuged EDTA-anticoagulated blood specimen tube revealing turbid plasma (lipemic blood).

Results of rerun after plasma replacement	
WBC ($\times 10^3$/μL)	4.9
RBC ($\times 10^6$/μL)	3.62
Hb (g/dL)	10.3
Hct (%)	29.5
MCV (fL)	81.5
MCH (pg)	28.4
MCHC (g/dL)	34.8
RDW (%)	17.0
PLT (10^3/μL)	60

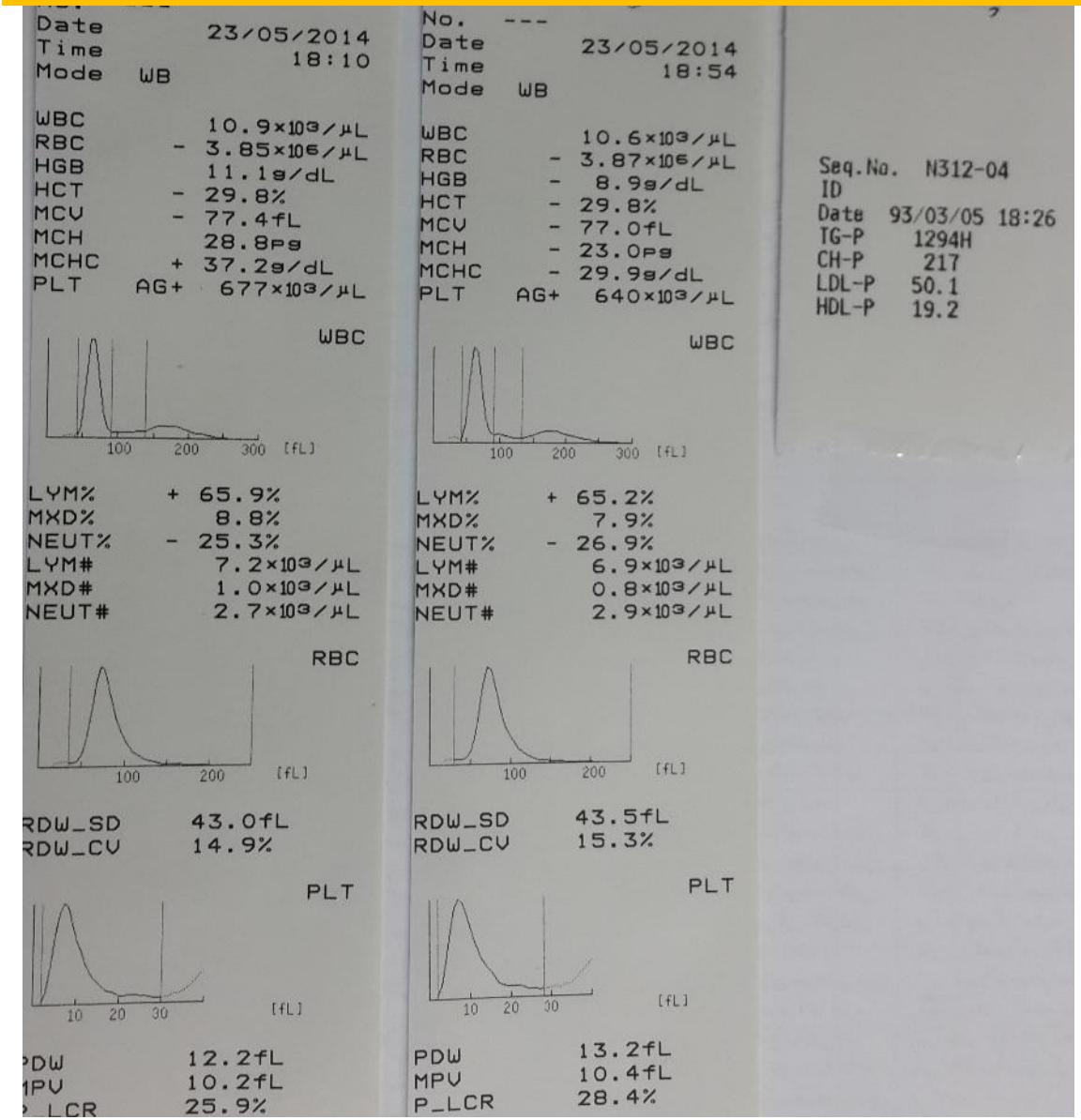
Lipemia interference

- **To obtain reliable results** :

1. a simple practical way: replacing the plasma with an isotonic solution → then reanalyze the specimen in the analyzer.
2. another approach: to measure plasma Hb concentration → and calculate the correct blood Hb concentration using the following formula:
   - ✓ **Correct Hb** = lipemic blood Hb − (1−Hct) × lipemic plasma Hb,

   and then recalculate the MCH & MCHC using the formulas:
   - ✓ **MCH** = Hb ×10÷RBC **MCHC** = Hb ×100÷Hct
3. one may: measure Hb concentration using a POC analyzer (HemoCue), which is unaffected by lipemia → then recalculate MCH & MCHC.
4. another approach: to dilute an aliquot of specimen with an isotonic diluent (e.g., 1:5) and rerun the analysis ☞ this approach may or may not yield reliable results. ☞ **If it works:**
   a. the WBC, RBC, Hb, Hct, PLT results should be corrected for the dilution.
   b. the MCV, MCH, MCHC, RDW values are unaffected by dilution ☞ do not require correction.

Lipemia interference



- If for some reason neither of the above approaches can be applied ☞ **one may choose**:
  1. to **report** only the reliable results, i.e., WBC, RBC, PLT, Hct, MCV, RDW,
  2. and append a **comment**:

"accurate Hb, MCH, and MCHC are not obtained due to lipemia"

Note:

- The Hb, MCH, and MCHC values are not reliable due to lipemia interference.

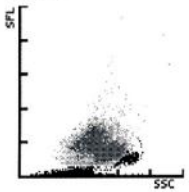
Interpretive Comment:

- It is recommended to repeat the test on a new fasting specimen.

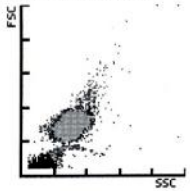
Sample No.: 126 Rack: Tube: 0 2009/03/10 12:01:58
Patient ID: Ward: Dr.:
Name: Birth: Sex:
Comments: Inst.ID:XT-1800i-1

Positive
Morph. Count

DIFF

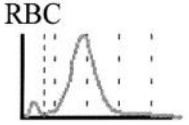


WBC/BASO

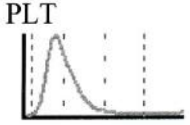


WBC	20.63	*	[10^3/uL]		
RBC	3.03	*	[10^6/uL]		
HGB	13.9	*	[g/dL]		
HCT	28.0	*	[%]		
MCV	92.4	*	[fL]		
MCH	45.9	*	[pg]		
MCHC	49.6	*	[g/dL]		
PLT	1151	*	[10^3/uL]		
RDW-SD	62.5	+	[fL]		
RDW-CV	19.9	+	[%]		
PDW	10.3	*	[fL]		
MPV	9.6	*	[fL]		
P-LCR	21.3	*	[%]		
PCT	1.10	*	[%]		
NEUT	----		[10^3/uL]	----	[%]
LYMPH	----		[10^3/uL]	----	[%]
MONO	----		[10^3/uL]	----	[%]
EO	0.45	*	[10^3/uL]	2.2 *	[%]
BASO	0.15	*	[10^3/uL]	0.7 *	[%]

RBC



PLT



WBC IP Message(s)
WBC Abn Scattergram
Leukocytosis

Immature Gran?
Abn Lympho/Blasts?
NRBC?

RBC IP Message(s)

RBC Agglutination?
Turbidity/HGB Interf?

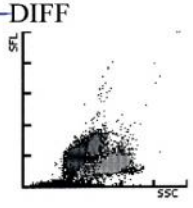
PLT IP Message(s)
Thrombocytosis

PLT Clumps?

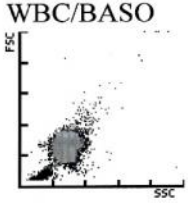
Sample No.: 125 Rack: Tube: 0 2009/03/10 11:58:20
Patient ID: Ward: Dr.:
Name: Birth: Sex:
Comments: Inst.ID:XT-1800i-1

Positive
Diff. Morph.
Count

DIFF

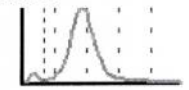


WBC/BASO

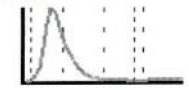


WBC	23.57	*	[10^3/uL]		
RBC	2.92		[10^6/uL]		
HGB	9.5		[g/dL]		
HCT	26.8		[%]		
MCV	91.8		[fL]		
MCH	32.5		[pg]		
MCHC	35.4		[g/dL]		
PLT	1015	*	[10^3/uL]		
RDW-SD	62.3	+	[fL]		
RDW-CV	19.8	+	[%]		
PDW	8.8	*	[fL]		
MPV	8.8	*	[fL]		
P-LCR	15.6	*	[%]		
PCT	0.89	*	[%]		
NEUT	14.96	*	[10^3/uL]	63.4 *	[%]
LYMPH	5.45	*	[10^3/uL]	23.1 *	[%]
MONO	2.92	*	[10^3/uL]	12.4 *	[%]
EO	0.18	*	[10^3/uL]	0.8 *	[%]
BASO	0.06	*	[10^3/uL]	0.3 *	[%]

RBC



PLT



WBC IP Message(s)
Neutrophilia
Lymphocytosis
Monocytosis
Leukocytosis

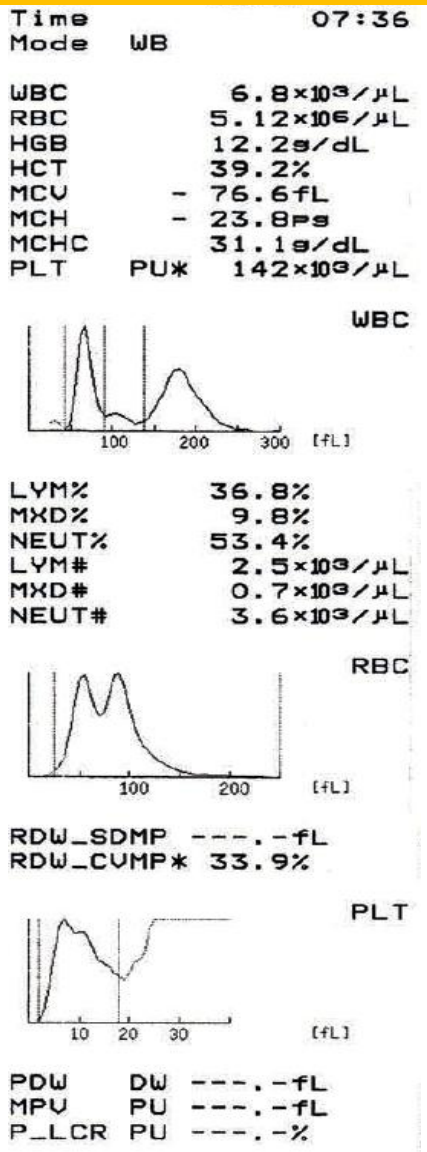
Immature Gran?
Abn Lympho/Blasts?
NRBC?

RBC IP Message(s)
Anemia

PLT IP Message(s)
Thrombocytosis

PLT Clumps?

Bimodal RBC histogram



32 years old female

- Double populations of red cells may exist in:
  - Patients on hematinic treatment,
  - Following blood transfusion
  - Dual (vitamin B_{12}/ folate and iron) deficiency anemia.
- Presence of a dual red cell population may only be visible on the RBC histogram or scatter plot and may not always be reflected in the numerical data due to the antagonistic effect of macrocytes and microcytes on the MCV.

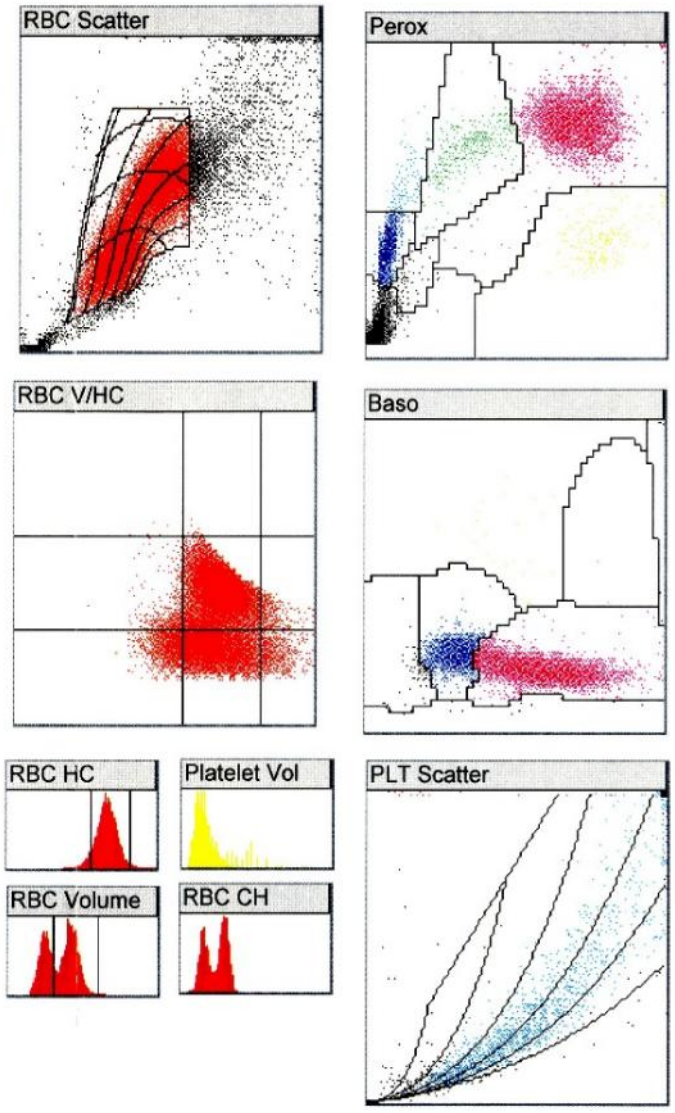
Patient Information	
Aspiration Date/Time	06/02/2012 12:51:04 PM
Sample Type	PATIENT
SID	20
FOR LABORATORY USE ONLY	

Differential Value			
%NEUT	55.6	*	
%LYMPH	31.1	*	
%MONO	6.8	*	
%EOS	3.6	*	
%Baso	0.6		
%LUC	2.4	*	
%NRBC			%(#NRBC/100 WBC)
#NEUT	3.60	*	x10³ cells/µL
#LYMPH	2.01	*	x10³ cells/µL
#MONO	0.44	*	x10³ cells/µL
#EOS	0.23	*	x10³ cells/µL
#BASO	0.04		x10³ cells/µL
#LUC	0.15	*	x10³ cells/µL
#NRBC			x10⁹ cells/L
#RETIC			x10⁹ cells/L
%RETIC			

Real value			
WBC		6.47	x10³ cells/µL
RBC		4.84	x10⁶ cells/µL
HGB	L	11.5	g/dL
HCT	L	34.4	%
MCV	L	70.9	fL
MCH	L	23.7	pg
MCHC		33.5	g/dL
CH		24.0	pg
RDW	H	27.7	%
HDW	H	3.54	g/dL
PLT		150	x10³ cells/µL
MPV		11.0	fL

Morphology Flags	
MICRO	+++
HYPO	+
ANISO	+++
HC VAR	+

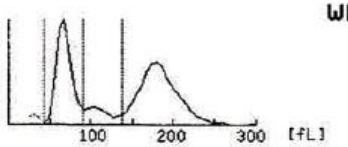
Due to their different size and Hb concentration leading to varying scatter properties, these populations can be identified on the RBC cytogram.



No. 13
Date 05/30/2012
Time 07:36
Mode WB

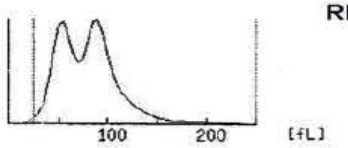
WBC 6.8×10³/µL
RBC 5.12×10⁶/µL
HGB 12.2g/dL
HCT 39.2%
MCV - 76.6fL
MCH - 23.8pg
MCHC 31.1g/dL
PLT PU* 142×10³/µL

WBC



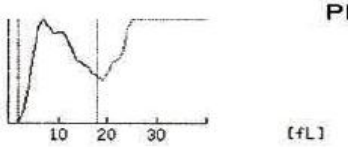
LYM% 36.8%
MXD% 9.8%
NEUT% 53.4%
LYM# 2.5×10³/µL
MXD# 0.7×10³/µL
NEUT# 3.6×10³/µL

RBC



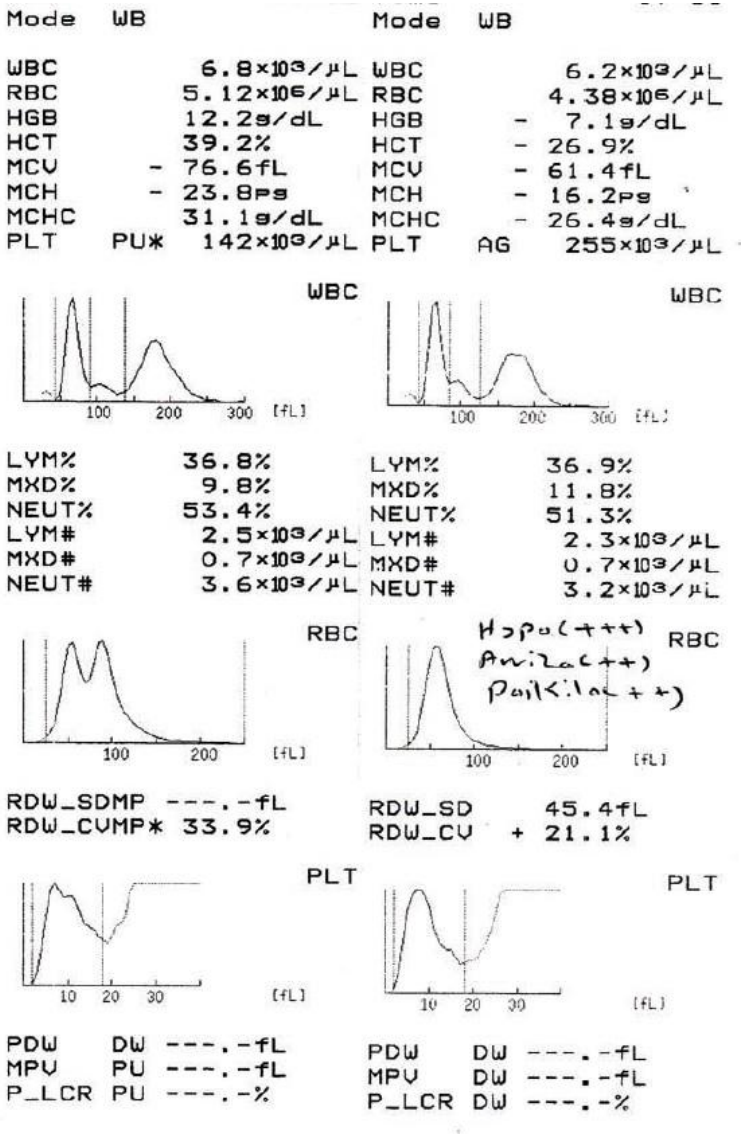
RDW_SDMP ---.-fL
RDW_CVMP* 33.9%

PLT



PDW DW ---.-fL
MPV PU ---.-fL
P_LCR PU ---.-%

Bimodal RBC histogram



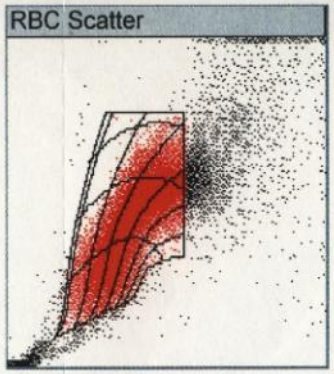
- This is a case of dimorphic anemia of a 32 years old female patient who is currently receiving iron supplements injections.
- As you can see in RBC distribution graph, there is two peak which is characteristic of dimorphic anemia.

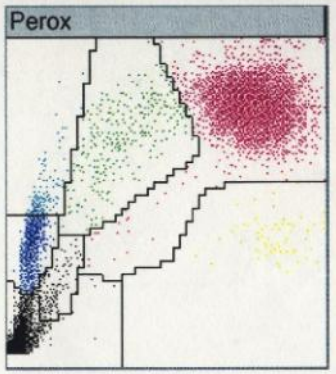
Patient Information	
Aspiration Date/Time	11/30/2011 11:47:14 AM
Sample Type	PATIENT
SID	23
FOR LABORATORY USE ONLY	

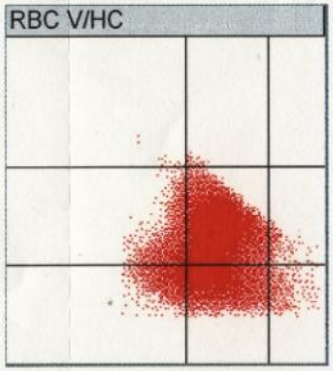
Differential Value			
%NEUT		71.7	
%LYMPH	L	17.9	
%MONO		5.9	
%EOS		1.3	
%Baso		0.2	
%LUC		2.9	
%NRBC		0.0	%(#NRBC/100 WBC)
#NEUT		4.46	x10³ cells/μL
#LYMPH		1.11	x10³ cells/μL
#MONO		0.37	x10³ cells/μL
#EOS		0.08	x10³ cells/μL
#BASO		0.01	x10³ cells/μL
#LUC		0.18	x10³ cells/μL
#NRBC		0.00	x10⁹ cells/L
#RETIC			x10⁹ cells/L
%RETIC			

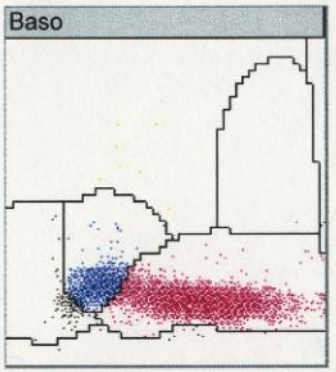
Real value			
WBC		6.21	x10³ cells/μL
RBC		4.88	x10⁶ cells/μL
HGB	L	11.1	g/dL
HCT	L	35.1	%
MCV	L	71.8	fL
MCH	L	22.7	pg
MCHC	L	31.6	g/dL
CH		23.3	pg
RDW	H	23.5	%
HDW	H	3.46	g/dL
PLT		189	x10³ cells/μL
MPV		10.7	fL

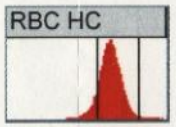
Morphology Flags	
MICRO	+++
HYPO	++
ANISO	+++
HC VAR	+

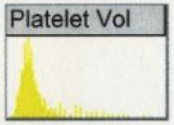


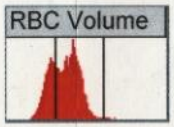


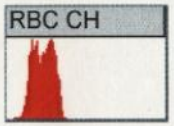


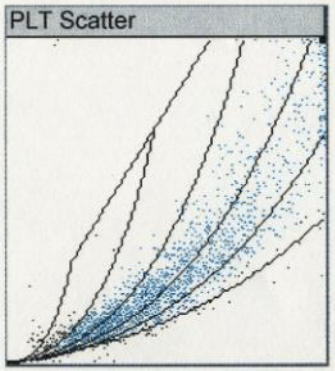








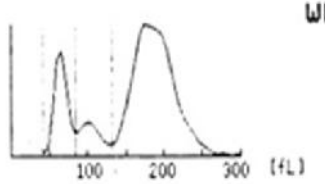




No. 145
Date 30/11/2011
Time 10:01
Mode WB

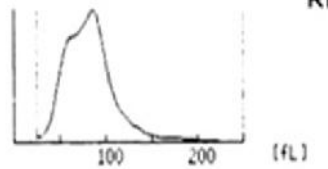
WBC	5.9×10³/μL
RBC	4.95×10⁶/μL
HGB	11.0g/dL
HCT	39.1%
MCV	79.0fL
MCH	- 22.2pg
MCHC	- 28.1g/dL
PLT	179×10³/μL

WBC



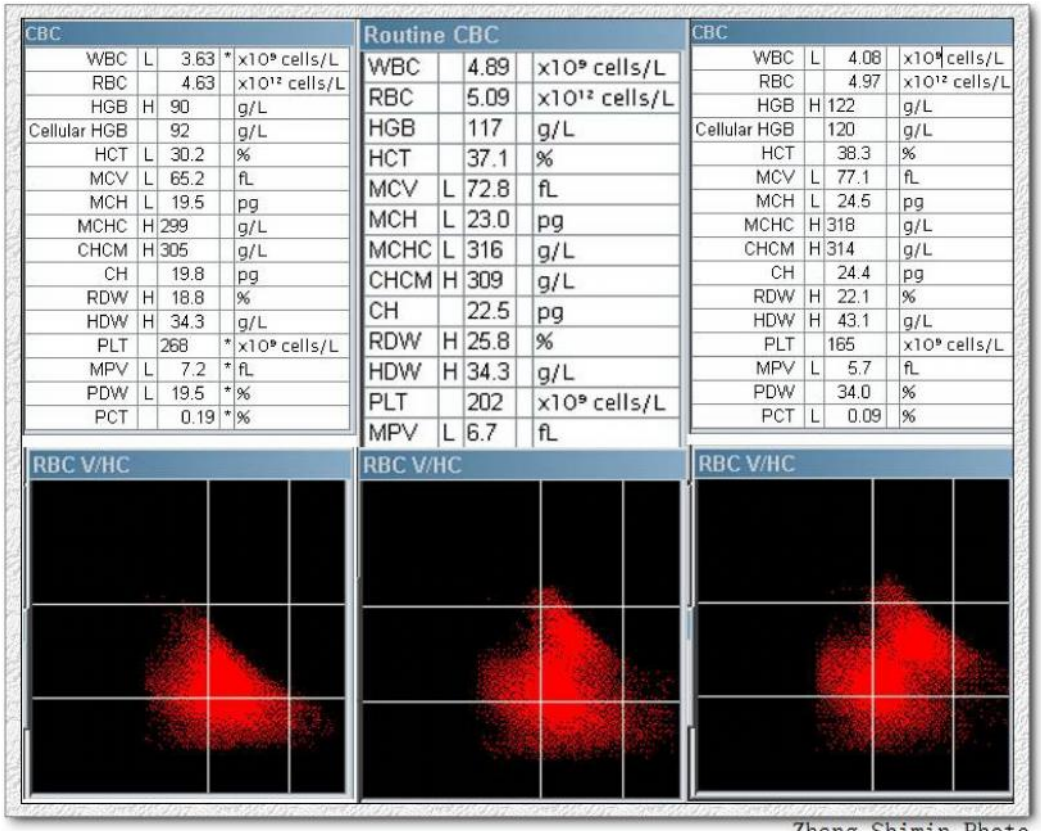
LYM%	18.5%
MXD%	9.6%
NEUT%	71.9%
LYM#	1.1×10³/μL
MXD#	0.6×10³/μL
NEUT#	4.2×10³/μL

RBC



RDW_SD + 71.9fL
RDW_CV + 25.9%

Bimodal distribution: effective reflection of iron treatment for iron deficiency anemia



CBC

WBC	L	3.63 *	x10⁹ cells/L
RBC		4.63	x10¹² cells/L
HGB	H	90	g/L
Cellular HGB		92	g/L
HCT	L	30.2	%
MCV	L	65.2	fL
MCH	L	19.5	pg
MCHC	H	299	g/L
CHCM	H	305	g/L
CH		19.8	pg
RDW	H	18.8	%
HDW	H	34.3	g/L
PLT		268 *	x10⁹ cells/L
MPV	L	7.2 *	fL
PDW	L	19.5 *	%
PCT		0.19 *	%

Routine CBC

WBC		4.89	x10⁹ cells/L
RBC		5.09	x10¹² cells/L
HGB		117	g/L
HCT		37.1	%
MCV	L	72.8	fL
MCH	L	23.0	pg
MCHC	L	316	g/L
CHCM	H	309	g/L
CH		22.5	pg
RDW	H	25.8	%
HDW	H	34.3	g/L
PLT		202	x10⁹ cells/L
MPV	L	6.7	fL

CBC

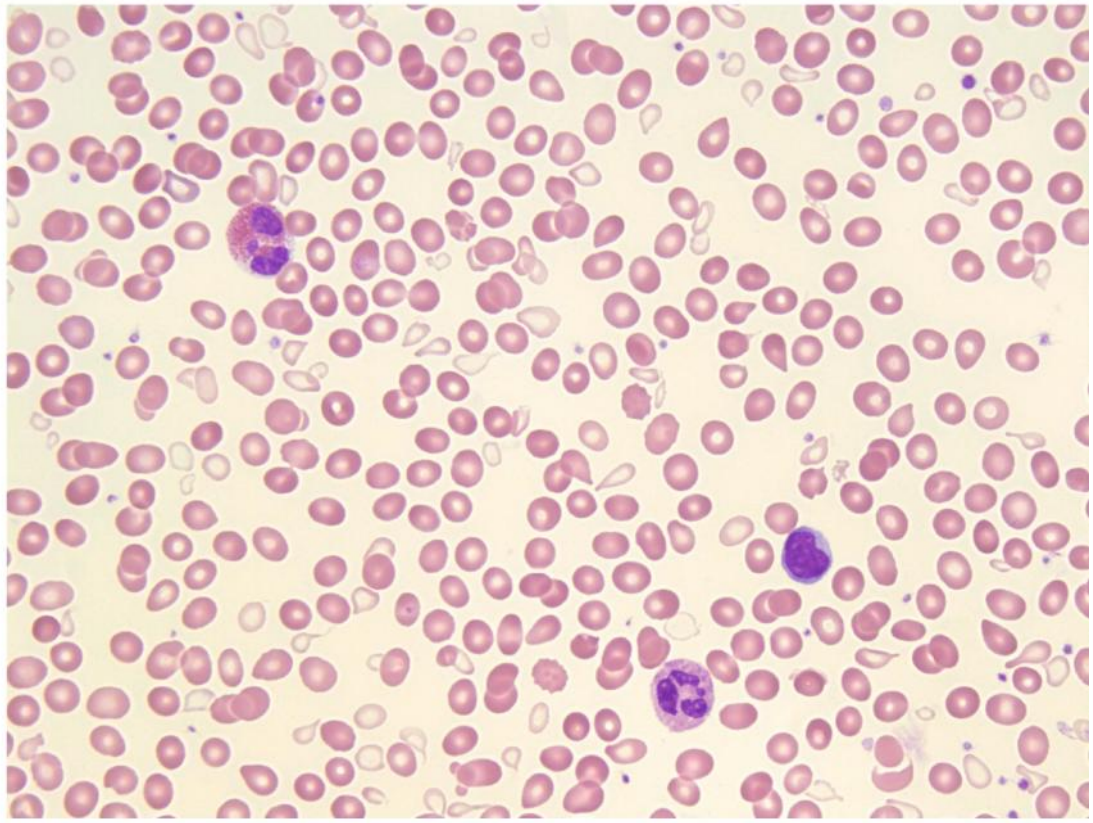
WBC	L	4.08	x10⁹ cells/L
RBC		4.97	x10¹² cells/L
HGB	H	122	g/L
Cellular HGB		120	g/L
HCT		38.3	%
MCV	L	77.1	fL
MCH	L	24.5	pg
MCHC	H	318	g/L
CHCM	H	314	g/L
CH		24.4	pg
RDW	H	22.1	%
HDW	H	43.1	g/L
PLT		165	x10⁹ cells/L
MPV	L	5.7	fL
PDW		34.0	%
PCT	L	0.09	%

RBC V/HC

RBC V/HC

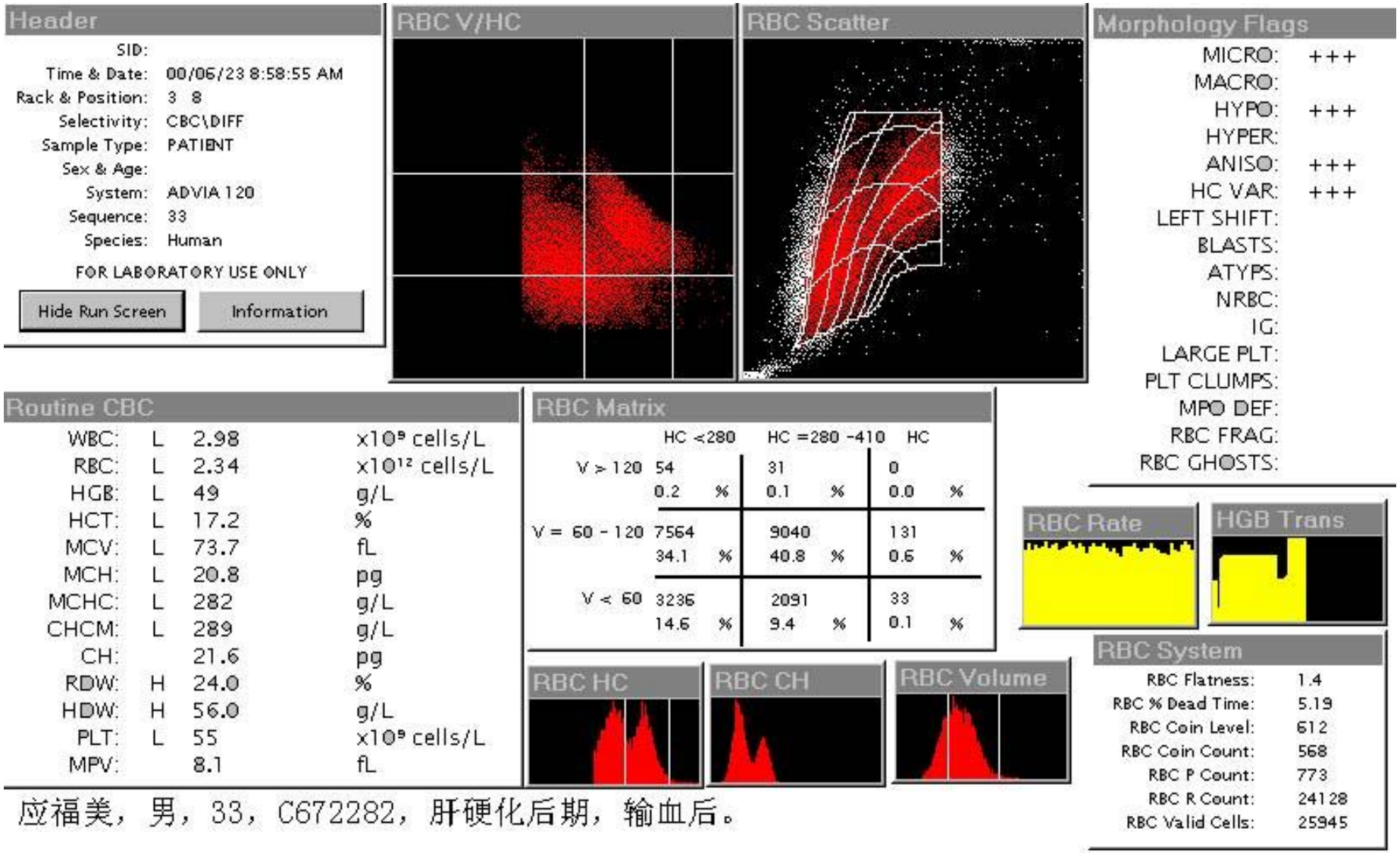
RBC V/HC

Zhang Shimin Photo



- A peripheral blood smear picture showing a dimorphic population of RBCs: hypochromic, microcytic RBCs and tear cells next to normochromic, normocytic RBCs (50X oil immersion).

It can also show a bimodal distribution after blood transfusion

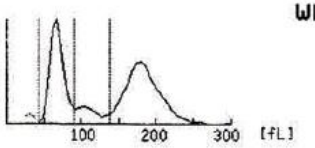


应福美，男，33，C672282，肝硬化后期，输血后。

No. 13
Date 05/30/2012
Time 07:36
Mode WB

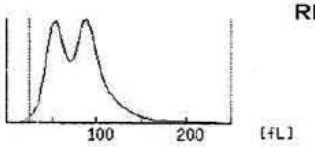
WBC		6.8×10³/μL
RBC		5.12×10⁶/μL
HGB		12.2g/dL
HCT		39.2%
MCV	-	76.6fL
MCH	-	23.8pg
MCHC		31.1g/dL
PLT	PU*	142×10³/μL

WBC



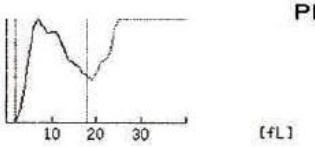
LYM%	36.8%
MXD%	9.8%
NEUT%	53.4%
LYM#	2.5×10³/μL
MXD#	0.7×10³/μL
NEUT#	3.6×10³/μL

RBC

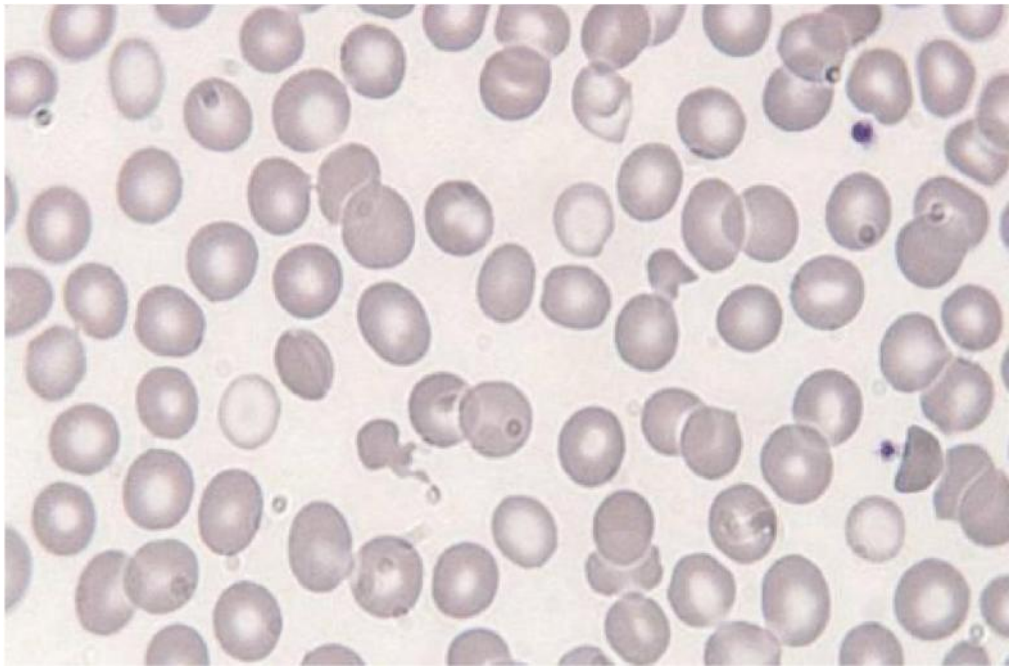


RDW_SDMP ---.-fL
RDW_CVMP* 33.9%

PLT



PDW DW ---.-fL
MPV PU ---.-fL
P_LCR PU ---.-%



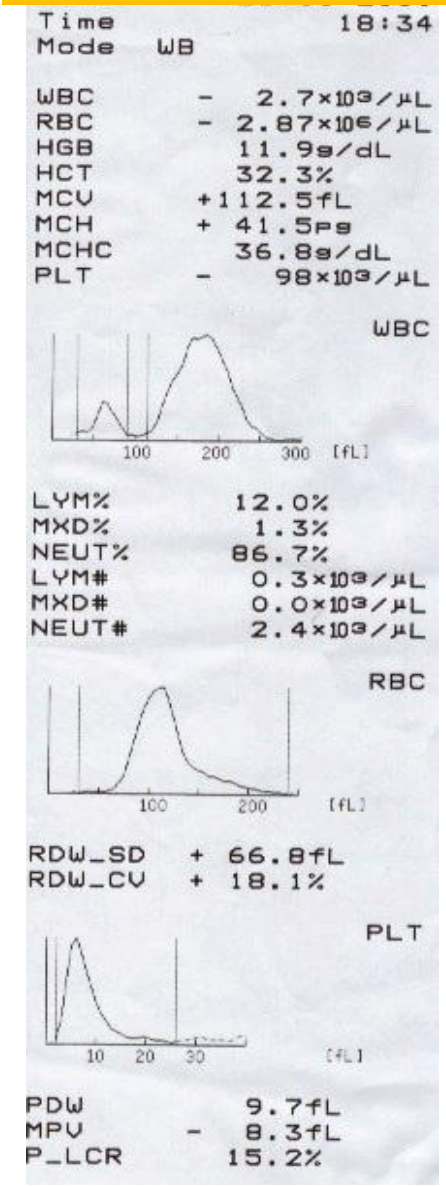
Note:

- The bimodal RBC histogram and MP flag demonstrates the presence of two populations of RBCs in peripheral blood.

Interpretive Comment:

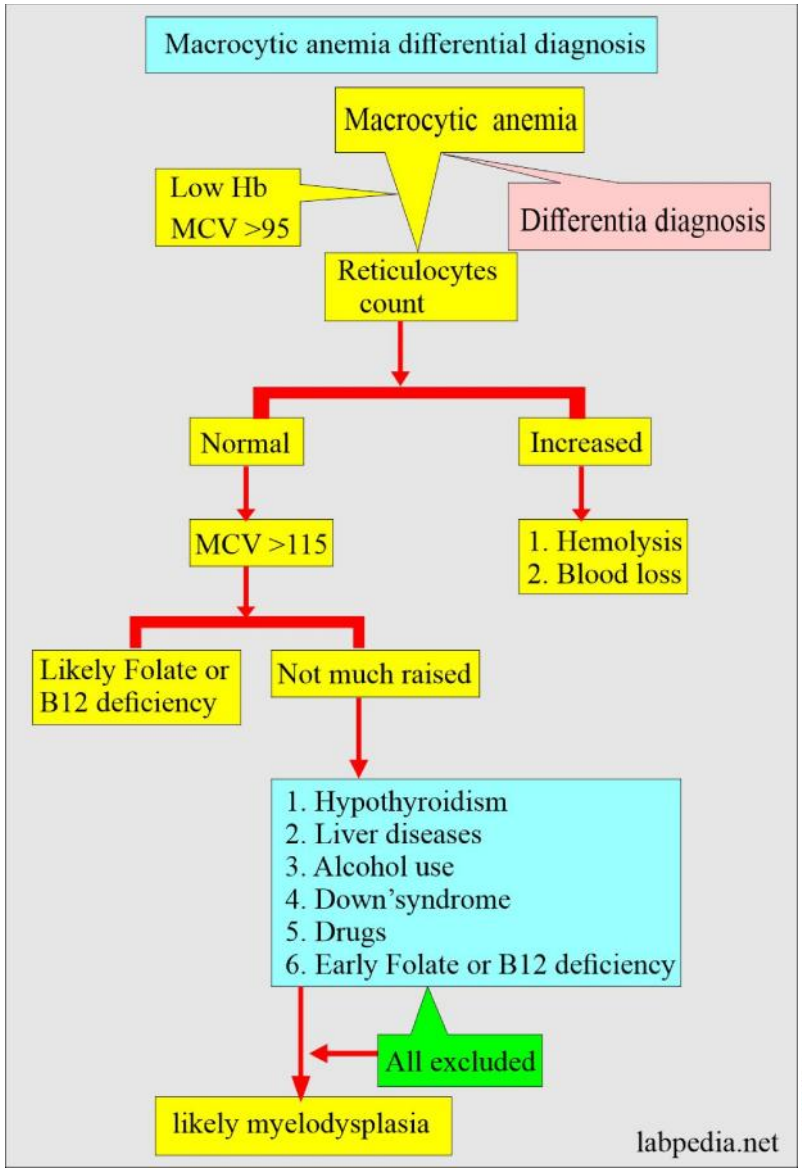
- **Dual population RBCs:** a combination of microcytic and normocytic red blood cells is seen on this peripheral blood film. This may represent partially treated iron deficiency (eg, transfused or treated with iron therapy) or a sideroblastic process. Clinical and laboratory correlation is required.

Macrocytic anemia



65 years old male

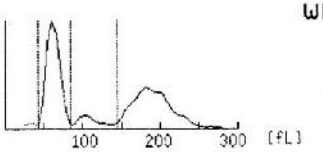
- Patients with macrocytic anemia due to vitamin B12/ folate deficiency may sometimes show a single widely distributed peak of cells from very small cells and red cell fragments on the left to macrocytic cells approaching 250 fL on the right.
- In severe megaloblastic anemia, the WBC and PLT histograms as well as the counts and the morphology may give additional information.



No. 101
Date 09/19/201
Time 10:0
Mode WB

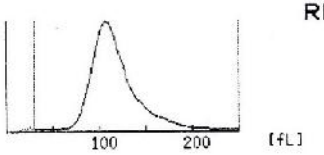
WBC	3.7×10³/μl
RBC	3.11×10⁶/μl
HGB	11.7g/dL
HCT	35.0%
MCV	+112.5fL
MCH	+ 37.6pg
MCHC	33.4g/dL
PLT	196×10³/μl

WBC



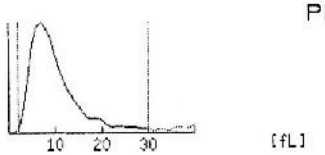
LYM%	44.6%
MXD%	8.6%
NEUT%	46.8%
LYM#	1.7×10³/μl
MXD#	0.3×10³/μl
NEUT#	1.7×10³/μl

RBC



RDW_SD	+ 56.8fL
RDW_CV	14.4%

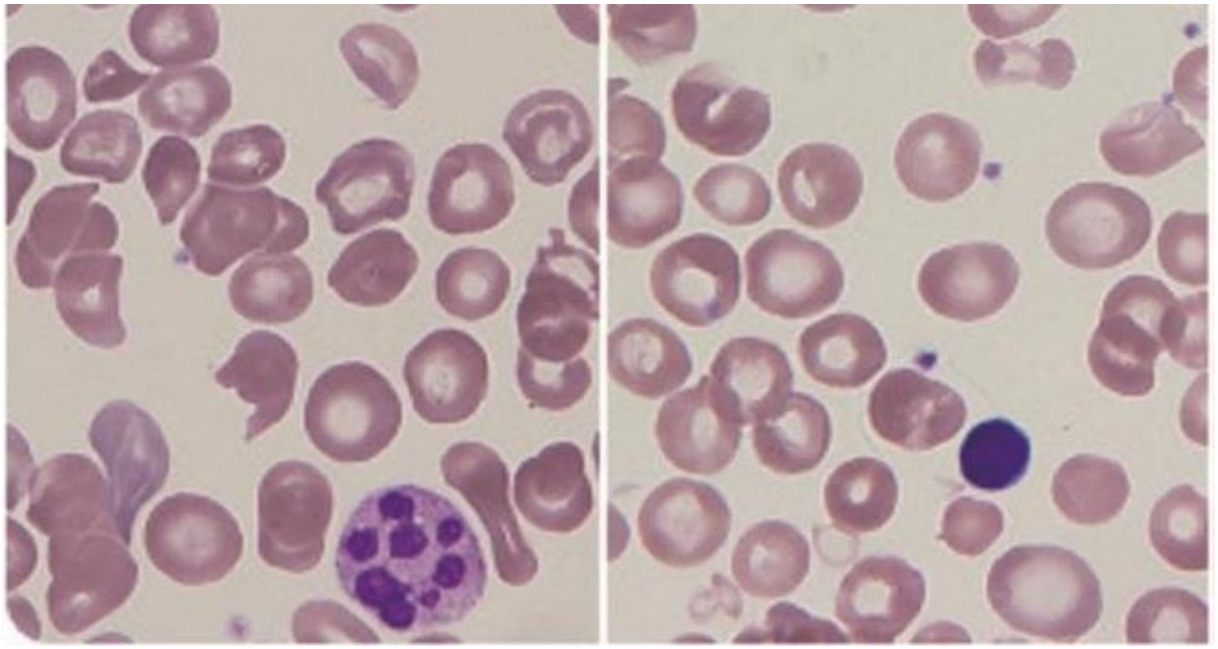
PLT



PDW	13.1fL
MPV	10.0fL
P_LCR	25.8%

Peripheral Blood Smear

- The presence of macro-ovalocytes having an MCV >115 fl, anisocytosis, poikilocytosis and hypersegmented neutrophils suggests a megaloblastic disorder associated with a nutritional deficiency, i.e., vitamin B12 or folate deficiency.



Interpretive Commnt:

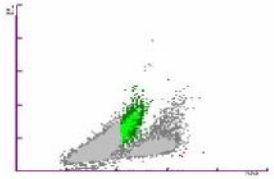
- **Macrocytosis.** Suggest excluding B12/folate deficiency, medication effect, liver and thyroid disease, alcohol use, reticulocytosis, and bone marrow abnormalities.

Leukoerythroblastic reaction

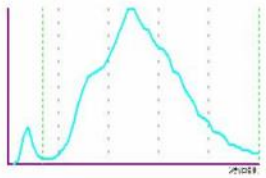
2 years old male

Test	Result	Unit	Age/Sex Based Reference Range	Differential	
C.B.C.					
W.B.C.	↑ **94.22**	10*3/µL	5.2 - 13	Neutrophils	42 %
Comment:	**Corrected WBC count: 44.360 / micro liter.**				
R.B.C.	↓ **2.18**	10*6/µL	3.7 - 5.2	Lymphocytes	43 %
Hgb	↓ **8.4**	g/dL	10.9 - 14.1	Monocytes	1.0 %
HCT	↓ **27.7**	micg/l	33 - 43	Eosinophils	0.0 %
M.C.V.	↑ **127.1**	fL	74 - 89	Basophils	0.0 %
M.C.H.	↑ **38.5**	pg	24 - 30	Metamyelocytes	2.0 %
M.C.H.C.	↓ **30.3**	g/dL	32 - 35.2	Myelocyte	3.0 %
Platelets	↑ **641**	10*3/µL	210 - 560	Promyelocyte	2.0 %
RDW-SD	↑ **132.2**	fL	30 - 49.2	Band Cells	7.0 %
RDW-CV	↑ **31.0**	micg/l	14.6 - 16.2		
PDW	9.5	fL	9.4 - 18.1		
MPV	9.1	fL	8.1 - 12.4		
P-LCR	18.1	micg/l	13 - 45		
Neutrophils	----	10*3/µL	1.2 - 7.5		
Lymphocytes	----	10*3/µL	1.5 - 8.5		
Monocytes	----	10*3/µL	0.15 - 1.2		
Eosinophils	----	10*3/µL	0.1 - 1.19		
Basophils	----	10*3/µL	0.02 - 0.2		
Others	Blood film demonstrates a leukoerythroblastic picture. Clinical and laboratory corelation is suggested to look for a peripheral cause (eg. hemorrhage, hemolysis, infection,...) versus a BM abnormality. Anisocytosis: +3, Macrocytes: +2, Spherocytes: +2, Giant PLT were seen.				
N.R.B.C.	87/ 100 WBC .				

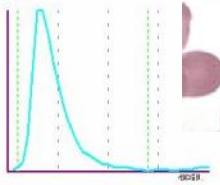
DIFF

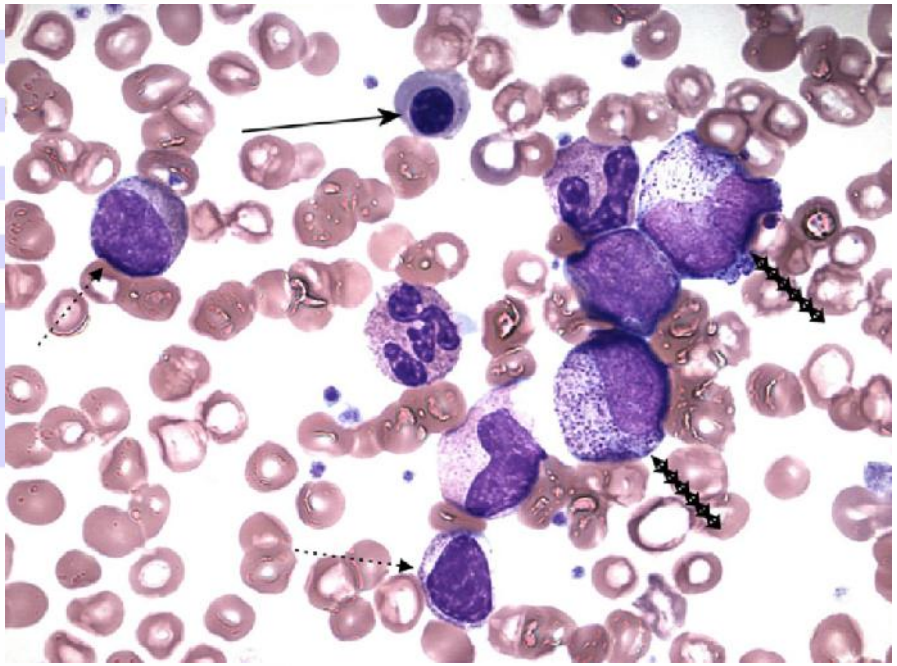


RBC



PLT





Leukoerythroblastic reaction

- A leukoerythroblastic blood film refers to the presence of granulocyte left shift as well as nucleated red blood cells on the same blood film.
  - This is always an abnormal finding, and may indicate a major acute stress or bone marrow infiltration.
  - Normoblasts as well as myeloblasts, promyelocytes, myelocytes and metamyelocytes may be present.

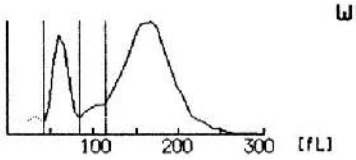
Interpretive Commnt:

- **Leukoerythroblastic picture:** Blood film demonstrates a leukoerythroblastic picture.
- Clinical and laboratory correlation is suggested to look for a peripheral cause (eg, hemorrhage, hemolysis, infection, inflammation, postsurgery, trauma) versus a bone marrow abnormality (eg, malignant infiltration, fibrosis).

RBC fragments/schistocytes

WBC		5.8×10³/μL
RBC	RL*	5.65×10⁶/μL
HGB	-	8.4g/dL
HCT	RL*	32.5%
MCV	RL*	57.5fL
MCH	RL*	14.9pg
MCHC	RL*	25.8g/dL
PLT	PU!	1884×10³/μL

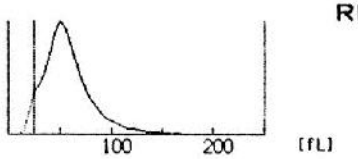
WBC



29 years old female

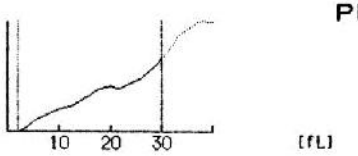
LYM%	21.0%
MXD%	7.2%
NEUT%	71.8%
LYM#	1.2×10³/μL
MXD#	0.4×10³/μL
NEUT#	4.2×10³/μL

RBC



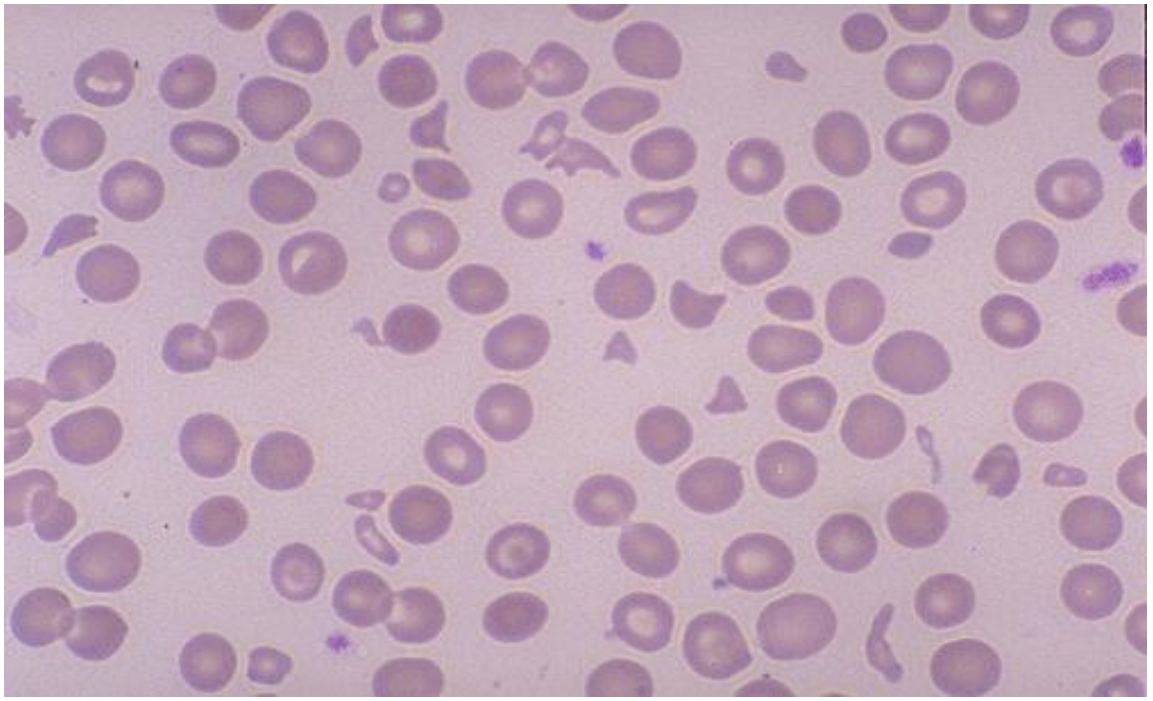
RDW RL* 32.3%

PLT



PDW	DW	---.-fL
MPV	PU	---.-fL
P-LCR	PU	---.-%

- Clinical conditions associated with the presence of RBC fragments include:
  1. disseminated intravascular coagulation (DIC),
  2. thrombotic thrombocytopenic purpura (TTP),
  3. malignant hypertension, prosthetic heart valve,
  4. severe burns, metastatic carcinoma,
  5. HELLP syndrome (hemolysis, elevated liver enzymes, and low PLTs),
  6. hereditary pyropoikilocytosis, and march hemoglobinuria.



RBC fragments/schistocytes

- RBC fragments/schistocytes
  - Schistocytes, may take various forms, including: helmet cells, bite cells, horn cells, triangular cells, and microspherocytes.
  - The fragment size is variable ☞ but often falls in the PLT counting range of many analyzers → are frequently counted as PLTs ⇒ falsely ↑ PLT count.
  - The presence of RBC fragments is confirmed by a PBS microscopic exam.

Results of initial run	
WBC ($\times 10^3$/μL)	6.3
RBC ($\times 10^6$/μL)	3.00*
Hb (g/dL)	7.5
Hct (%)	24.0*
MCV (fL)	80.0*
MCH (pg)	25.0*
MCHC (g/dL)	31.3*
RDW (%)	27.9*
PLT (10^3/μL)	219*

Helpful indicators: RBC and PLT counts flagged, abnormal RBC and PLT histograms, fragments

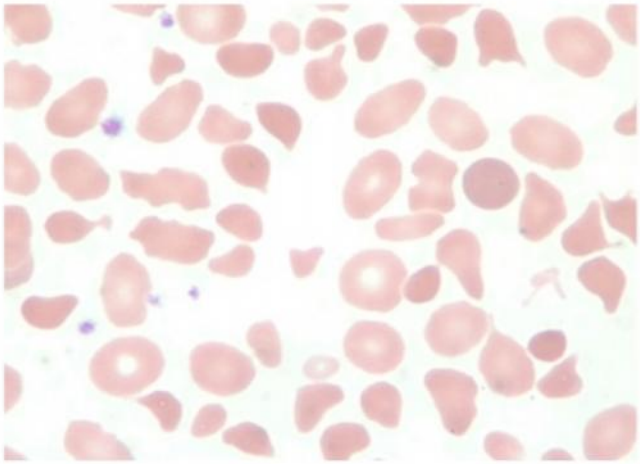
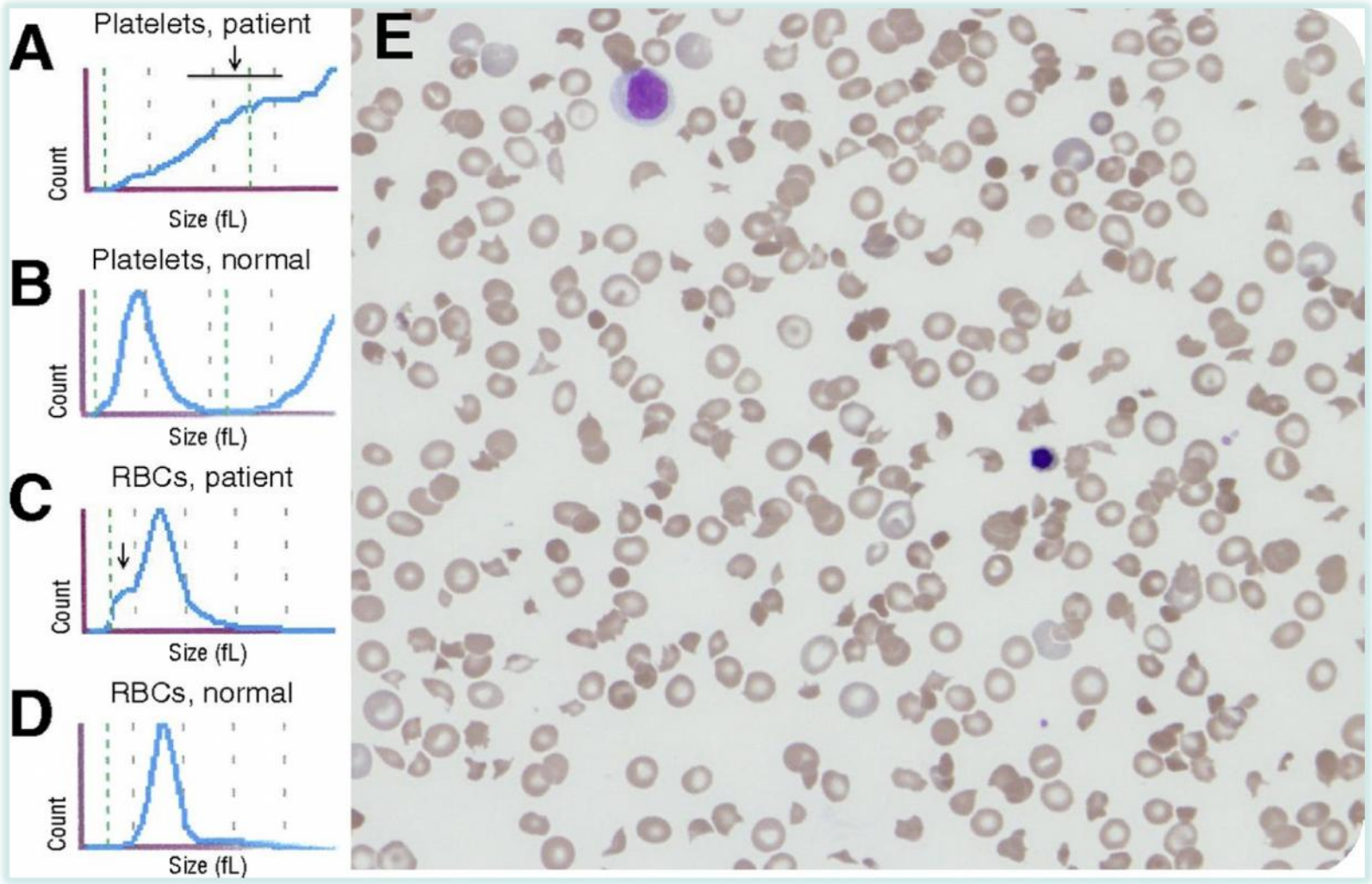


Fig. 8. Blood smear (Wright–Giemsa, ×1,000) revealing several RBC fragments (schistocytes).

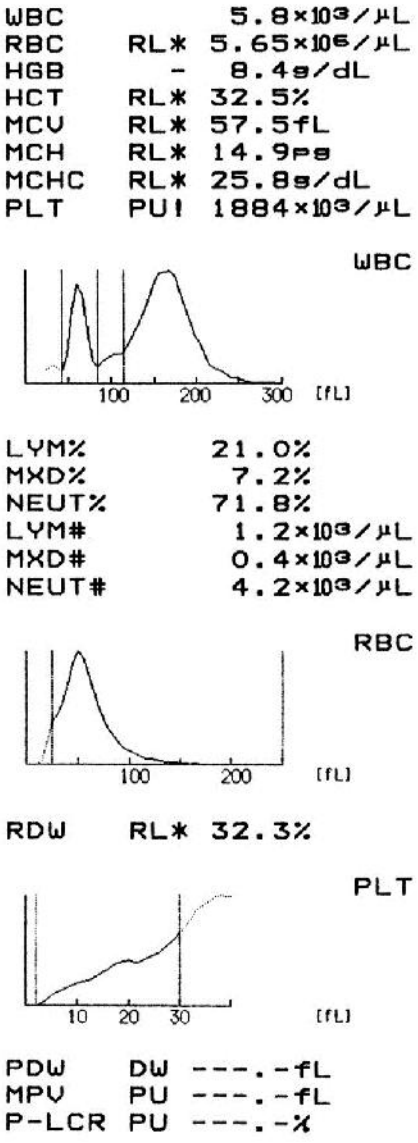
Results after blood smear review	
WBC ($\times 10^3$/μL)	6.3 (initial)
RBC ($\times 10^6$/μL)	3.00 (initial)
Hb (g/dL)	7.5 (initial)
Hct (%)	24.0 (initial)
MCV (fL)	80.0 (initial)
MCH (pg)	25.0 (initial)
MCHC (g/dL)	31.3 (initial)
RDW (%)	27.9 (initial)
PLT (10^3/μL)	100 (estimated from smear)

RBC fragments/schistocytes

- RBC fragments/schistocytes
  - Analyzer flag(s), RBC & PLT histograms, and unexpected PLT results ☞ are helpful indicators of falsely ↑ PLT count.



RBC fragments/schistocytes



- **To obtain reliable results** [in a high number of schistocytes (graded as ≥2+) on PBS]:
  1. one may choose to replace the automated PLT count with an estimated PLT count (from PBS)
  2. or perform a manual PLT count using phase microscopy.
  3. Optical PLT counting with or without fluorescence may also yield a reliable PLT count in some cases.

Note:

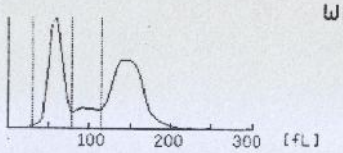
- The automated PLT count is not reliable due to presence of fragmented RBCs.

Interpretive Commnt:

- **RBC Fragments and thrombocytopenia.** Red blood cell fragments are seen approximately ___% with thrombocytopenia.
- This is suggestive of a microangiopathic hemolytic process with thrombocytopenia.
- Clinical and laboratory correlation are suggested to exclude the following entities: DIC, TTP, HUS, HELLP, vasculitis, sepsis, malignant hypertension, disseminated malignancy, etc.

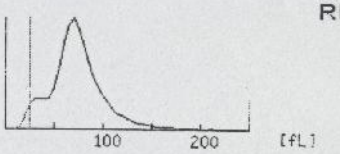
Date		17/05/2019
Time		08:27
Mode		WB
WBC	-	3.0×10³/µL
RBC	RL*	4.15×10⁶/µL
HGB	-	9.1g/dL
HCT	RL*	29.8%
MCV	RL*	71.8fL
MCH	RL*	21.9pg
MCHC	RL*	30.5g/dL
PLT	PU*	659×10³/µL

WBC



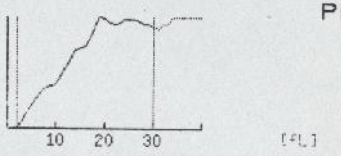
LYM%		37.1%
MXD%	+	11.4%
NEUT%		51.5%
LYM#		1.1×10³/µL
MXD#		0.3×10³/µL
NEUT#		1.6×10³/µL

RBC



RDW_SDDW		---.-fL
RDW_CVRL*		29.4%

PLT



PDW	DW	---.-fL
MPV	PU	---.-fL
P_LCR	PU	---.-%

Patient Information	
Aspiration Date/Time	05/11/2019 12:02:04 PM
Sample Type	PATIENT
SID	

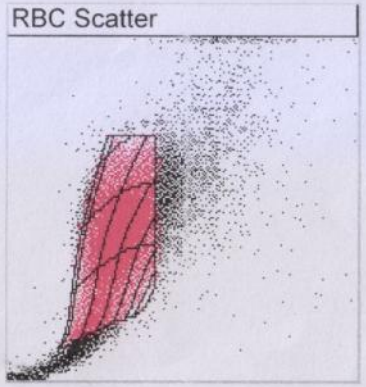
FOR LABORATORY USE ONLY

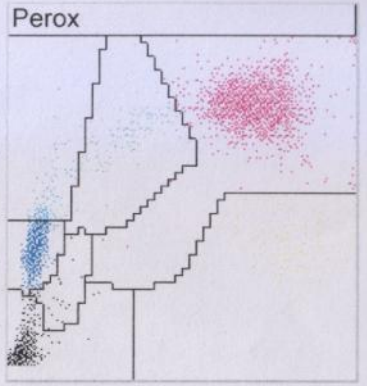
Differential Value			
%NEUT		55.4	
%LYMPH		30.4	
%MONO		5.0	
%EOS		3.5	
%Baso		0.6	
%LUC	H	5.2	
%NRBC			%(#NRBC/100 WBC)
#NEUT	L	1.61	x10³ cells/µL
#LYMPH	L	0.88	x10³ cells/µL
#MONO	L	0.14	x10³ cells/µL
#EOS		0.10	x10³ cells/µL
#BASO		0.02	x10³ cells/µL
#LUC		0.15	x10³ cells/µL
#NRBC			x10⁹ cells/L
#RETIC			x10⁹ cells/L
%RETIC			
LI	L	1.73	

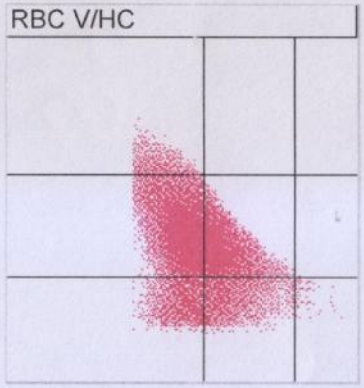
Real value			
WBC	L	2.91	x10³ cells/µL
RBC	L	4.20	x10⁶ cells/µL
HGB	L	9.5	g/dL
HCT	L	33.2	%
MCV	L	79.1	fL
MCH	L	22.7	pg
MCHC	L	28.7	g/dL
CH		21.4	pg
RDW	H	23.5	%
HDW	H	3.41	g/dL
PLT	L	37	x10³ cells/µL
MPV		7.5	fL

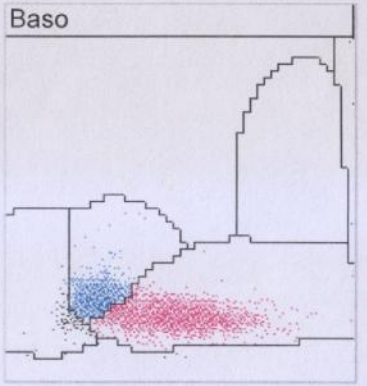
Morphology Flags	
MICRO	+++
HYPO	+++
ANISO	+++
HC VAR	+
ATYPS	+
RBC FRAG	+

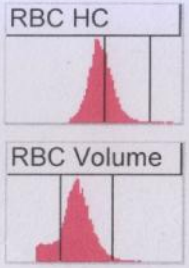
- **To obtain reliable results**:
  1. replacement of the automated PLT count with an estimated PLT count (from PBS)
  2. a manual PLT count using phase microscopy.
  3. Optical PLT counting with or without fluorescence

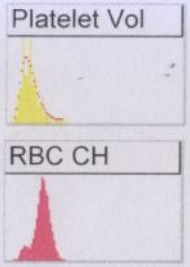


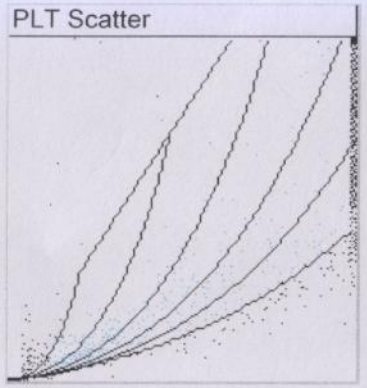




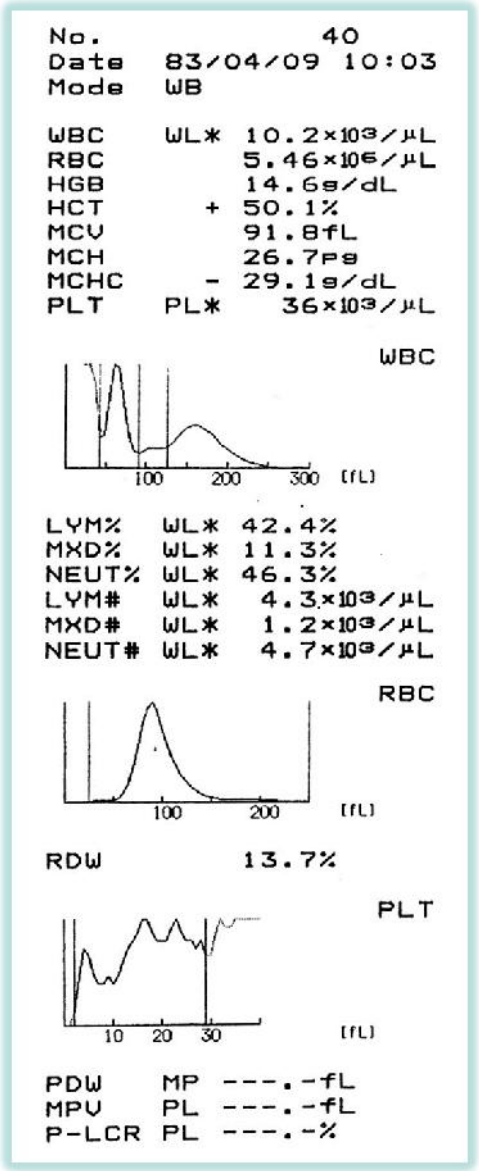






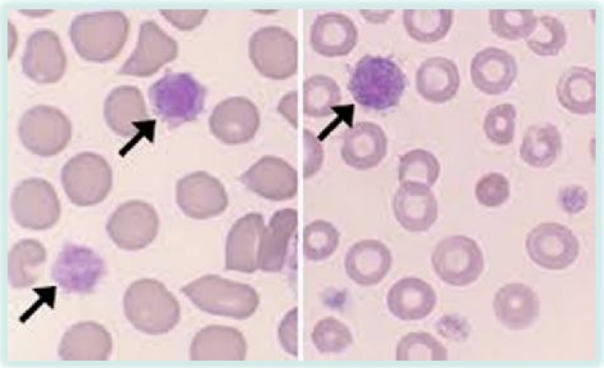


Giant PLTs



30 years old female

- When present in high numbers, giant PLTs:
  1. frequently result in a falsely ↓ PLT count
  2. and occasionally may result in a falsely ↑ WBC count.
  - ✓ The RBC parameters (RBC, MCV, Hct, MCH, MCHC) may also be affected ☞ but these changes are generally not clinically significant and not worth spending time to correct.



Giant PLTs

- The presence of giant PLTs is:
  - ✓ often suspected by review of analyzer-generated flag(s), histograms, and scattergrams
  - ✓ and confirmed by microscopic exam of a PBS.

Results of initial run	
WBC ($\times 10^3$/μL)	9.4*
RBC ($\times 10^6$/μL)	4.70
Hb (g/dL)	13.9
Hct (%)	42.6
MCV (fL)	91.0
MCH (pg)	29.6
MCHC (g/dL)	32.7
RDW (%)	15.0
PLT (10^3/μL)	38

Useful indicators: WBC count flagged

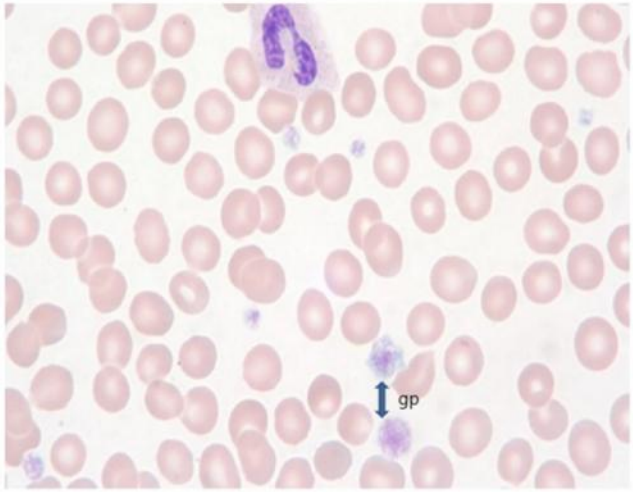


Fig. 10. Blood smear (Wright–Giemsa, ×1,000) revealing two giant PLTs (gp).

Results after blood smear review	
WBC ($\times 10^3$/μL)	9.4 (estimated from blood smear, 9.0)
RBC ($\times 10^6$/μL)	4.70 (initial)
Hb (g/dL)	13.9 (initial)
Hct (%)	42.6 (initial)
MCV (fL)	91.0 (initial)
MCH (pg)	29.6 (initial)
MCHC (g/dL)	32.7 (initial)
RDW (%)	15.0 (initial)
PLT (10^3/μL)	100 (estimated from blood smear)

*Flagged by the analyzer.

Giant PLTs

- **To obtain a reliable PLT count:**
  1. one may resort to manual counting in a hemocytometer using phase microscopy
  2. or preferably, report an estimated PLT count obtained from PBS according to the generally recommended or Lab's predefined criteria.
  - ✓ Similarly, an estimated WBC count is reported in case of an unreliable automated WBC count as evidenced by a discrepancy between the automated and estimated counts.

Giant PLTs

- PLT size is of diagnostic significance particularly when considered in relation to the PLT count.
  - A normal PLT measures 1.5–3 μm in diameter.
  - Large PLTs measure 3–7 μm (roughly the diameter of a normal sized RBC),
  - Giant PLTs, are larger than normal sized RBCs at 10–20 μm in diameter and are flagged by automated analysers.
  - ✓ In a normal person, usually <5% of the PLTs appear large.
- It is recommended that giant PLTs be graded.
- A comment about the platelet count and the presence of small, large or giant platelets can be made with an additional interpretive film comment if appropriate.

Note:

- The automated PLT count is not reliable due to presence of giant PLTs.

Interpretive Comment:

- **Isolated thrombocytopenia** with no platelet clumping or red blood cell fragmentation. Suggest excluding idiopathic thrombocytopenic purpura, medication effect, infectious process, bone marrow abnormality, peripheral destruction, and hypersplenism.

Thanks for your attention