Dude… Where's My Blood?

Evaluation of Anemia in Hospitalized Patients

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No disclosures

First a refresher on the basics…

Definition

According to the World Health Organization anemia is defined as a hemoglobin level of less than 13 g/dL in men and less than 12 g/dL in women.

*****Symptom not a disease*****

HEMOGLOBIN

13.5g/dl-16.0g/dl

HIGH

-Hypoxia (Smoking, OSA, Lung Dx, High Altitude, CO)
-Dehydration
-Polycythemia Vera (JAK2V617F)
-EPO producing tumors (Liver, Renal, Hemangioblastoma, Pheo, Uterine)

LOW

-Nutritional Deficiency (Iron, B12, Folate)
-Blood Loss (Trauma, GI Tract, Hematoma)
-Hemodilution
-Hemolysis
-Renal Failure
-Chronic Disease

Evaluation

Vital signs

Reticulocyte Count

MCV

A Few Lab Geek Secrets

Vital Signs

Blood Pressure

Heart Rate

Oxygen saturation

Respiratory Rate

Reticulocytes

Reticulocytes (% corrected) = Reticulocytes x (HCT /45)

RPI = Reticulocytes (%corrected) /Correction Factor

Correction Factor

HCT 40-45 = 1

HCT 35-39 = 1.5

HCT 25-34 = 2

HCT 15-24 =2.5

HCT < 15 = 3

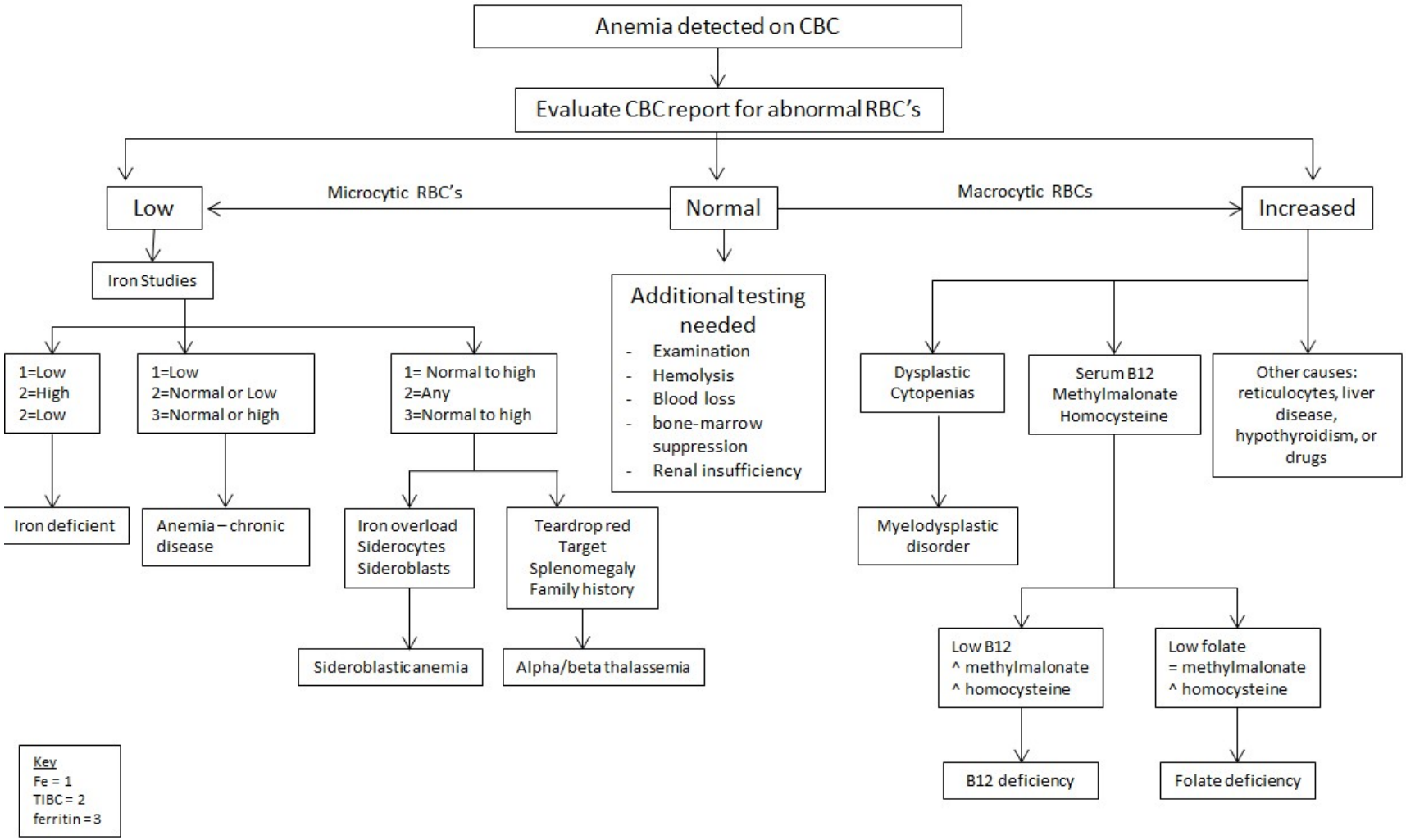
RPI > 2.0

Acute Blood Loss

Hemolytic Anemia

Response to Therapy (5-7days)

But what if RPI <2.0???


Anemia detected on CBC
Evaluate CBC report for abnormal RBC's
Low
Microcytic RBC's
Normal
Macrocytic RBCs
Increased
Iron Studies
1=Low
2=High
2=Low
1=Low
2=Normal or Low
3=Normal or high
1= Normal to high
2=Any
3=Normal to high
Additional testing needed
- Examination
- Hemolysis
- Blood loss
- bone-marrow suppression
- Renal insufficiency
Dysplastic Cytopenias
Serum B12
Methylmalonate
Homocysteine
Other causes: reticulocytes, liver disease, hypothyroidism, or drugs
Iron deficient
Anemia – chronic disease
Iron overload
Siderocytes
Sideroblasts
Teardrop red
Target
Splenomegaly
Family history
Myelodysplastic disorder
Sideroblastic anemia
Alpha/beta thalassemia
Low B12
^ methylmalonate
^ homocysteine
Low folate
= methylmalonate
^ homocysteine
B12 deficiency
Folate deficiency
Key
Fe = 1
TIBC = 2
ferritin = 3

Patients don’t always read the books…

CENSUS

Mrs. Salty
Mr. Weakness
Mister Carwash
Mrs. Red
Mrs. Organic
Mrs. Carrot
Mrs. Pale

Mrs. Salty

PMH
Coronary Artery Disease

PSH:
Cataract Removal

SOCIAL HISTORY:
Single. Nonsmoker. No alcohol.

MEDS:
Aspirin 325mg daily.

ROS:
Nausea. Vomit x 1. Friends all have the "GI Bug"

******Vomited x1 this morning. "Kinda dark colored" Came to ER. ******

Lab	Physical 3 months ago	ER Labs
Hemoglobin	13.3	6.8
Platelets	296	151
Sodium	138	146
Chloride	100	119
Potassium	4.8	3.1
Creatinine	1.0	0.9
BUN	20	16

****Vital signs stable. No current complaints****

“Saltines, Sierra Mist, and 2units of PRBCs and sending her up”

Lab	Physical 3 months ago	ER Lab	Floor Lab
Hemoglobin	13.3	6.1	14.6
Platelets	296	171	111
Sodium	138	146	140
Chloride	100	119	101
Potassium	4.8	3.1	5.1
Creatinine	1.0	0.9	1.1
BUN	20	16	21

Most important next step?

A. Check Reticulocytes
B. Octreotide infusion
C. EGD
D. Obtain H. Pylori Serology
E. Fire the phlebotomist

Drip Arm

Speaking of IV fluids and anemia lets check on our next patient…

Mr. Weakness

PMH
Hypertension
Chronic Kidney Disease
Osteoarthritis

PSH:
None.

SOCIAL HISTORY:
Married. Neversmoker. No ETOH.

MEDS:
Metoprolol, ASA, Simvastatin

ROS:
Progressive weakness, GERD, Joint Pain

LABS

Lab	Admission	Day 2	Day 3
Hemoglobin	9.8 (Baseline 10)	8.4	7.8
MCV	87	88	91
Platelets	206	259	214
Sodium	141	138	140
Potassium	4.8	5.2	5.2
Bicarbonate	20	21	23
Creatinine	1.4 (Baseline 1.5)	1.5	1.5
BUN	28	35	42
AST	52	-	-
ALT	55	-	-
UA	Negative	-	-
TSH	1.8	-	-

Your review of vitals…

Normal saline running 100cc/hr since admission

Weight is up 3kg

Fluid balance is +2.7L

LABS

Lab	Admission	Day 2	Day 3
Hemoglobin	9.8 (Baseline 10)	8.4	7.8
MCV	87	88	91
Platelets	206	259	214
Sodium	141	138	140
Potassium	4.8	5.2	5.2
Bicarbonate	20	21	23
Creatinine	1.4 (Baseline 1.5)	1.5	1.5
BUN	28	35	42
AST	52	-	-
ALT	55	-	-
UA	Negative	-	-
TSH	1.8	-	-

Now what?

A. EGD
B. Colonoscopy
C. Peripheral Smear
D. CT Abdomen
E. Stop IVF and give Furosemide
F. Give Aranesp
G. Transfer to SNF for continued PT/OT

BLOOD UREA NITROGEN
6-21mmol/L

AZOTEMIA

-Dehydration
-Rapid protein catabolism
-CHF
-Shock
-MI
-High protein diet
-Anabolic effect of systemic corticosteroids

LOW

-Liver failure
-Malnutrition
-Nephrotic syndrome

EGD = Duodenal Ulcer
Hgb 7.8. What next?

A. Transfuse 1 unit of PRBCs

B. Transfuse 2 units of PRBCs

C. Iron supplementation

D. Monitor closely

E. Toradol, Dexamethasone, place PEG and inject live cultures of H. Pylori into stomach

Transfuse?

Transfusion Strategies for Acute Upper Gastrointestinal Bleeding
Villanueva, MD et. al.
The New England Journal of Medicine, 2013

Liberal or Restrictive Transfusion in High Risk Patients after Hip Surgery
Jeffrey Carson, MD et al
The New England Journal of Medicine, 2011

Lower versus Higher Hemoglobin Threshold for Transfusion in Septic Shock
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Transfuse?

Impact of More Restrictive Blood Transfusion Strategies on Clinical Outcomes: A Meta-analysis of Systematic Review
Salpeter, MD et al
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Restrictive versus liberal transfusion strategy for red blood cell transfusions: systematic review of randomized trials with meta-analysis and trial sequence analysis
Holst, et al
BMJ 2015

Outcomes Using Lower vs Higher Hemoglobin Thresholds for Red Blood Cell Transfusion
Carson, MD et al
Journal of American Medical Association 2013

Red Blood Cell Transfusion: A Clinical Practice Guideline From the AABB
Carson, MD et al
Annuals of Internal Medicine, 2012

Coronary Artery Disease?

Liberal versus restrictive transfusion thresholds for patients with symptomatic coronary artery disease

American Heart Journal, 2013

Say you did transfuse…

Which of the following theoretically would not increase after transfusion?

A. Potassium
B. Bilirubin
C. White Blood Cells
D. Platelets
E. Risk of TRALI/TACO

What about this next guy though?

Mr. Carwash

PMH
None.

PSH:
None.

SOCIAL HISTORY:
Single. Positive THC and ETOH use on weekends only.

MEDS:
None.

ROS:
Fell asleep at work.

LABS

Hgb	**6.8**
Creatinine	**6.8**
Kidney Bx	FSGS

Transfuse?

A. Yes
B. No

Moving along…

Mrs. Red

PMH
None.

PSH:
None.

SOCIAL HISTORY:
Married. Beet farmer. Neversmoker. No alcohol.

MEDS:
Aspirin 325mg daily.

ROS:
Tired. Red urine. Weight loss.

LABS

Lab	Result
Hemoglobin	8.4
MCV	74
WBC	7000
Platelets	116,000
Sodium	136
Potassium	4.6
Glucose	133
Bicarbonate	19
Creatinine	0.9
BUN	19

Next test?

A. Iron studies
B. INR
C. UA
D. All of the above

Lab	Result
Hemoglobin	**8.4**
MCV	**74**
WBC	7000
Platelets	**116,000**
Sodium	136
Potassium	4.6
Glucose	**133**
Creatinine	0.9
BUN	19
UA	**Negative**
Iron	**24**
TIBC	**578**
Ferritin	**9**
INR	**1.5**

What next?

A. Hold Aspirin. Give FFP and Vitamin K
B. Urology consult for Cystoscopy
C. Colonoscopy
D. Hemoglobin electrophoresis
E. Ferrous Sulfate BID. Recheck 1 month
F. Avoid beets. Recheck 1 month

Mrs. Red

Red urine = Beeturia

Elevated Protime and Thrombocytopenia = Chronic DIC

Colonoscopy = Colon Cancer

Deferred on further treatment.

Discharged home.

What else causes microcytic anemia?

Microcytic Anemia

* Iron Deficiency
* Thalassemia
* Chronic Disease
* Lead Poisoning
* Sideroblastic Anemia
*Aluminum Toxicity
*Copper Deficiency
*Zinc Poisoning

Work Up:

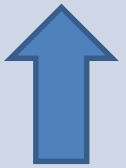
*Serum Iron

*TIBC

*Ferritin

*RDW

*Peripheral Smear

LAB	Iron Deficiency Anemia	Anemia of Chronic Disease
Iron		
TIBC		 
Ferritin		 

Cause of IDA?

Acute Blood Loss

Decreased dietary intake

Impaired absorption

Increased Requirements

Our next patient awaits…

Mrs. Carrot

PMH
St. Jude Aortic Valve
OSA
Atrial Fibrillation
HTN

PSH:
Right Total Hip Arthroplasty
Aortic Valve Replacement

SOCIAL HISTORY:
Married. Neversmoker. No ETOH.

MEDS:
Warfarin, Metoprolol, HCTZ, and Melatonin

ROS:
Admitted from ER for weakness and dyspnea

LABS

Lab	On discharge from Cardiac Surgery	Admit Labs
Hemoglobin	12.7	9.6
MCV	87	88
Platelets	206	259
Sodium	141	138
Potassium	4.8	5.9
Bicarbonate	25	28
Creatinine	1.0	0.9
BUN	20	21
AST	79	251
ALT	86	----
Bilirubin	1.2	3.8
INR	2.6	3.3

Now What?

A. Abdominal CT

B. Call GI Bleed Team

C. FFP and Vitamin K

D. Peripheral Smear

E. Right Upper Quadrant US

F. *Plasma* Potassium

Lab	Discharge from CV Surgery	Admit Labs
Hemoglobin	12.7	9.6
MCV	87	88
Platelets	206	259
Sodium	141	138
Potassium	4.8	5.9
Bicarbonate	25	28
Creatinine	1.0	0.9
BUN	20	21
AST	79	251
ALT	86	----
Bilirubin	1.2	3.8
INR	2.6	3.3
Haptoglobin	--	3
LDH	--	980
Peripheral Smear	--	Schistocytes, Helmet Cells

Hemolysis

Up

- Potassium
- AST
- LDH
- Bilirubin (Indirect)
- Reticulocytes

Down

- Hemoglobin
- Haptoglobin

BILIRUBIN

0.1-1.0mg/dL

-Choledocholithiasis (most common)

-Liver Disease

-Hemolysis (Indirect)

-Recent transfusion

-Gram Negative Sepsis

-TPN

-Obstruction (Tumor, Mass, Stone)

-Gilberts Disease

LDH

122-222U/L

-Heart Disease (MI)
-Tissue Infarction (Renal, Pulmonary)
-Hemolysis
-Liver Disease (Hepatitis, Cirrhosis, Cholangitis)
-Malignancy (Lymphoma, Myeloma, Leukemia)

Present in liver, heart, kidney, RBC, WBC, Lungs, Platelets, skeletal muscle, prostate
Any cellular damage causes elevation

Haptoglobin

30-200mg/dL

Increased:

-Inflammation
-Infection
-Malignancy
-Surgery
-Trauma
-Corticosteroids

Decreased:

-Hemolysis
-Liver disease
-Malnutrition
-Estrogens
-Pregnancy

Reticulocytes

0.5-2.0%

Elevated:

Hemolytic Anemia
Acute Blood Loss
Response to Therapy (5-7days)

Low or Normal:

All other forms of anemia

Coombs

Immune vs. Nonimmune?

(+) Alloimmune, Autoimmune, Drug Induced

(-) HS, G6PD, PNH, HUS, DIC, Mechanical, Infection

Moving along…

Mrs. Organic

PMH
None.

PSH:
None.

SOCIAL HISTORY:
Married to a Hospitalist PA. 3 boys. (6 month old twins and 5 year old).
Nonsmoker. No recent alcohol use because of nursing.

MEDS:
None.

ROS:
Dyspnea and fatigue.

LABS

Lab	
Hemoglobin	10.7
MCV	115
Platelets	206
Sodium	141
Potassium	4.6
Creatinine	1.0
BUN	20
AST	42
ALT	39
Bilirubin	1.2
TSH	1.0

What should we order for her?

A. B12 and Folate
B. Peripheral smear
C. Iron studies
D. Diapers and a New Minivan

LABS

Lab	
Hemoglobin	10.7
MCV	115
Platelets	206
Sodium	141
Potassium	4.6
Creatinine	1.0
BUN	20
AST	42
ALT	39
Bilirubin	1.2
TSH	1.0
B12	168
Folate	8

What did she eat for dinner last night?

A. Steak
B. Tofu
C. Chicken
D. Sushi
E. White Castle Sliders (Organic ones of course)

Macrocytosis

* **B12 Deficiency** (Pernicious Anemia, Surgical Resection of ileum, sprue, fish tapeworm, bacterial overgrowth, vegans)

* **Folate Deficiency** (ETOH, Pregnancy, Medications)

* Hypothyroidism

* Drugs (AZT, MTX, Hydroxyurea, Bactrim, Valacyclovir, Triamterene, Phenytoin)

* Liver disease

* Myelodysplastic Syndromes

* Reticulocytosis

B12 and Folate Pearls

- Higher the MCV, more likely the etiology
- Folate heavily influenced by diet ***Fasting***
- RBC Folate?
- MMA and Homocysteine ***Renal Disease***
- Low folate can falsely lower B12 (33% of time)
- Hypersegmented neutrophil
- Intrinsic Factor Antibody (70% Pernicious)

Last patient awaits…

Mrs. Pale

PMH
Osteoporosis

PSH:
None.

SOCIAL HISTORY:
Married. Nonsmoker. Retired. Likes to knit hats.

MEDS:
Calcium and Vitamin D

ROS:
Frequent falls.

**********Family no longer can care for her**********

LABS

Lab	Admission	Day 2	Day 3	Day 4	Day 5
Hgb	13.0	12.3	11.7	11.1	10.4
MCV	87	88	91	91	91
Platelets	206	259	214	200	205
Sodium	141	138	140	138	142
Potassium	4.8	4.7	4.8	4.3	4.6
Creatinine	1.0	0.9	1.1	1.0	0.9
BUN	19	20	20	18	20
AST	52	50	51	58	54
ALT	55	48	44	46	49
Calcium	9.0	10.1	9.8	9.5	9.4
Albumin	4.0	3.9	4.2	4.4	3.8

Next best treatment?

A. Stop drawing her blood
B. Stop drawing her blood
C. Stop drawing her blood
D. Stop drawing her blood

Roughly, how much blood does your marrow make in one day?

A. 10ml
B. 50ml
C. 100ml
D. 350ml

Roughly, how much blood does it take to run CBC, Electrolytes, and Liver Enzymes?

A. 1ml

B. 5ml

C. 10ml

D. 30ml

Hospital Acquired Anemia

Do Blood Tests Cause Anemia in Hospitalized Patients?
Paaladinesh Thavendiranathan, MD, et al
J GEN INTERN MED 2005; 20:520–524.

Hospital-Acquired Anemia: Prevalence, Outcomes, and Healthcare Implications
Colleen G. Koch et al
Journal of Hospital Medicine
September 2013 Volume 8

Hospital Acquired Anemia and in-hospital mortality in patients with acute myocardial infarction
Salisbury et al
American Heart Journal, 2011

Causes

Procedural Blood Loss

Recurrent Phlebotomy

Impaired Erythropoiesis

Hemodilution

Effects

Increased in hospital mortality

Increased length of stay

Increased hospital charges

What can you do?

Daily labs? Do you really need them?

Microdraws

Stored serum

“Lets Run The List”

Mrs. Salty
Mr. Weakness
Mister Carwash
Mrs. Red
Mrs. Carrot
Mrs. Organic
Mrs. Pale

Questions?

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References

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