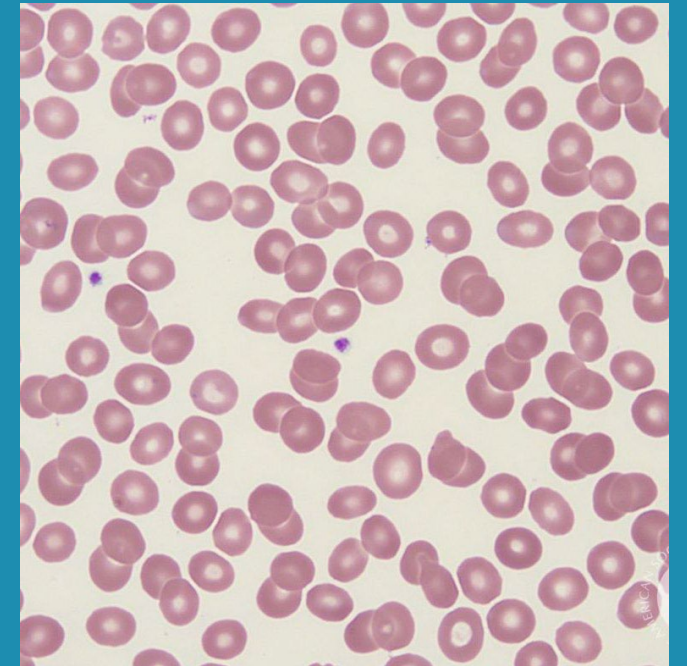


Anemia

Peter Vandenberghe, Hematology Dept, UZ Leuven
BHS Course 10/10/2026



Definition

- Reduced RBC mass (♂ 28-35 ml/kg; ♀ 23-30ml/kg) (not routinely available in standard practice)
- Decreased hemoglobin concentration in peripheral blood
 - WHO : ♂ < 13g/dl; ♀ <12g/dl (adults)
 - Practical: Hb below the reference value (of the performing laboratory) for age and sex matched reference population of healthy controls



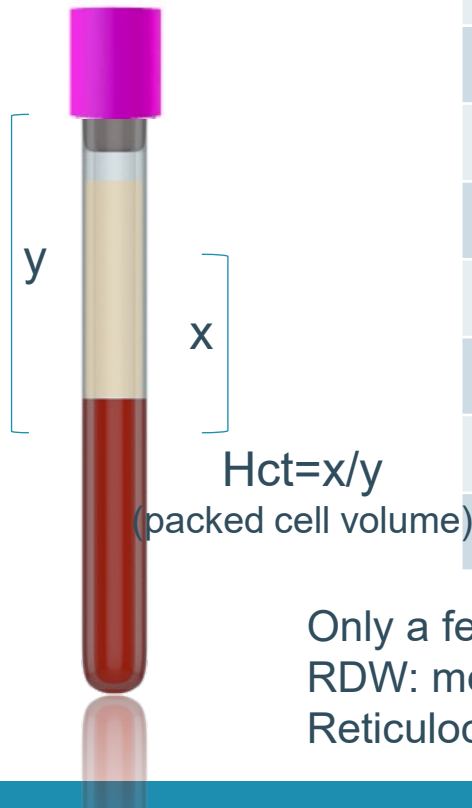
Red blood cell indices

Parameter	Adult ♂	Adult ♀	Unit
Hemoglobin (Hb)	14,0-18,0	12,0-16,0	g/dL
Hematocrit (Hct)	41-53	37 – 47	%
RBC-count	4,50-5,90	3,90-5,60	$10^{12}/L$
MCV (mean corpuscular volume)	80-98	76,0-96,0	fL
MCH (mean corpuscular hemoglobin)	26,0-34,0	27,0-32,0	pg
MCHC (mean corpusc. Hb concentr.)	31,0-36,0	30,0-35,0	g/dL
RDW (red cell distribution width)	11.6 - 14.8	11,7-14,5	%
Reticulocyte count	20-100		$10^9/L$
Reticulocyte count	0,5-2,0		%

Only a few parameters are measured (Hb, RBC number, MCV): others are calculated

RDW: measure of anisocytosis

Reticulocytosis: absolute reticulocytosis is preferable to relative; “corrected reticulocyte count” as alternative

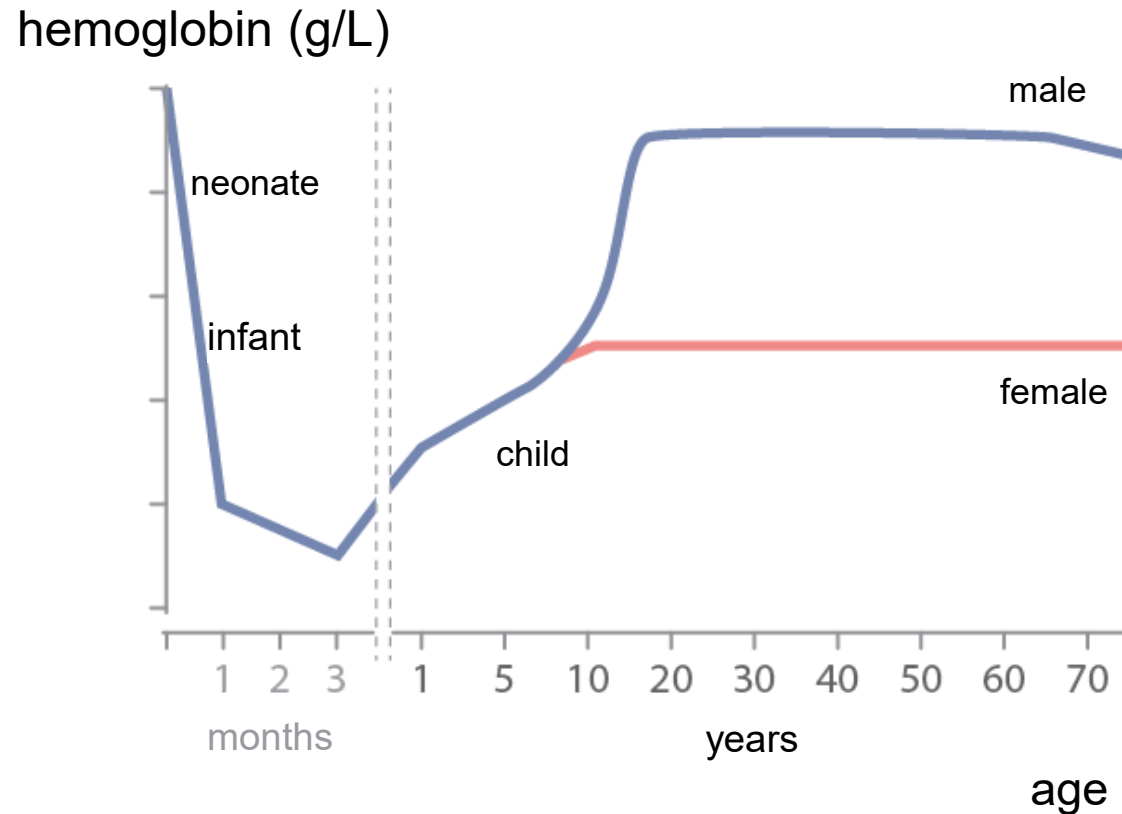


Red blood cell parameters are relative and influenced by volume shifts



	Dehydration, exercise, diuretics and fasting	In case of significant bleeding, blood donation	3d after major bleeding, blood donation	Vochtexpansie	Fluid expansion and EPO in riders
Plasma volume	↓	↓	↑ to normal	↑	↑
RBC Mass	=	↓	↓	=	↑
Result Hb	↑	=	↓	↓	=

Red blood cell parameters are age-related



- Neonate: higher Hb (in utero!)
- Elderly: is “anemia of the elderly” a specific biological entity?

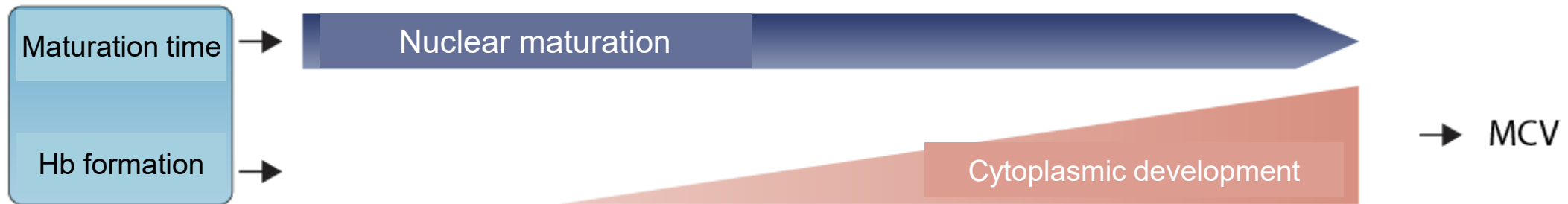
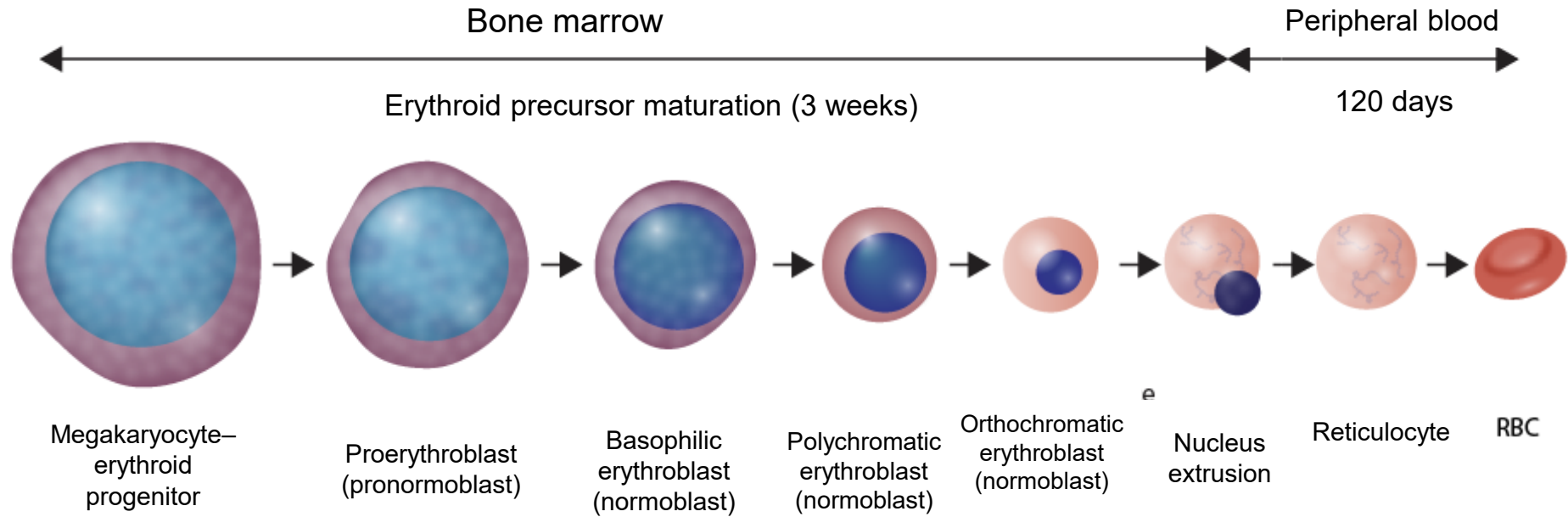
Epidemiology

- Worldwide
 - 30% of the population
 - ♂ < ♀
 - Children > adults
 - Iron deficiency, hemoglobinopathy, anemia of chronic disease, malaria, other tropical diseases (hookworm, schistosomiasis,..)
- Western world
 - ♂ < ♀
 - Children < adults
 - Iron deficiency, anemia of chronic disease, (hemoglobinopathy, ↑)

Anemia

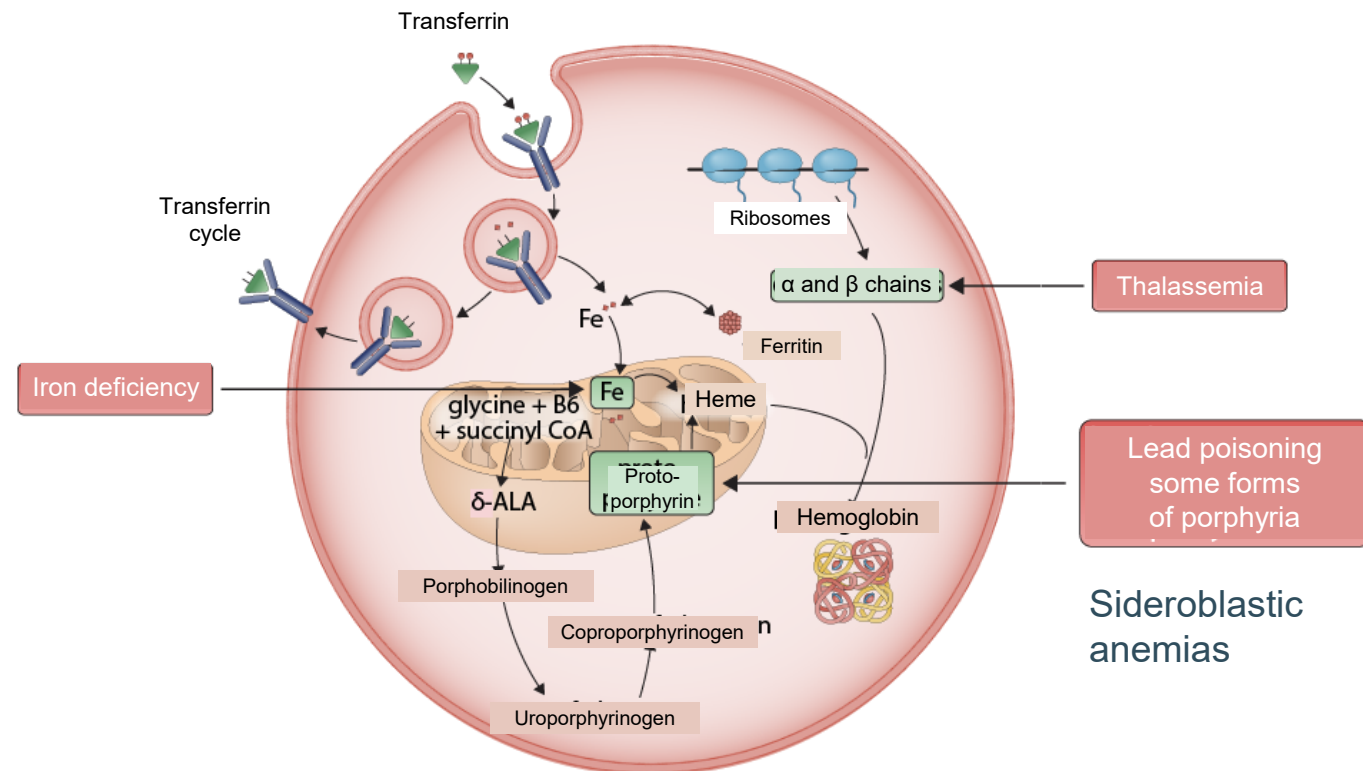
- Often managed by non-hematologists (GP, other specialisms, ...)
- On hematology wards or day care units: highly selected types of anemia
 - myelosuppressive therapies
 - bone marrow failure (MDS >> aplastic anemia >> inborn errors, ...)
 - bone marrow infiltration by hematological neoplasms..... but common causes of anemia can confound the picture
- Consultative hematology on non-hematology wards
 - Much wider spectrum of etiologies, much less enriched with above entities
 - More complex and multifactorial etiologies

Erythropoiesis: $\sim 0.2 \times 10^{12}$ erythrocytes/day

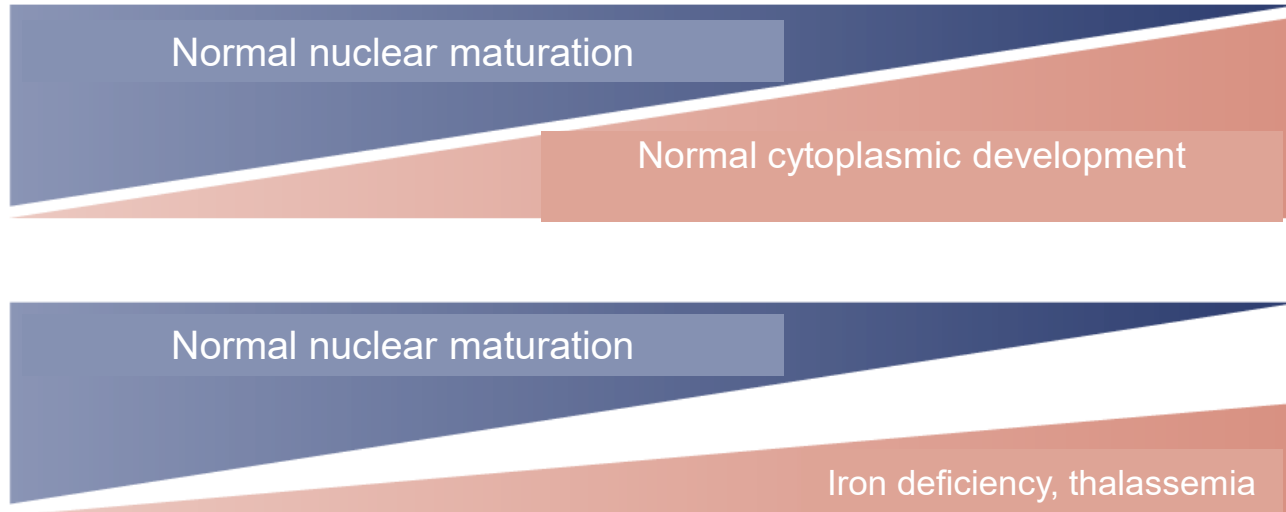


Cytoplasmic maturation = formation of Hb

- 4 globin chains (2 x 2)
 - [Embryonic $\gamma_2\epsilon_2$, $\gamma_2\delta_2$, $\alpha_2\epsilon_2$]
 - Fetal: HbF ($\alpha_2\gamma_2$)
 - Adult: HbA ($\alpha_2\beta_2$) $\gg$ HbA2 ($\alpha_2\delta_2$), HbF ($\alpha_2\gamma_2$)
- 4 heme molecules
 - 4 protoporphyrin molecules
 - 4 x Fe^{2+}
- Deficiencies of these three building blocks result in decreased production of Hb, thus decreased MCV and microcytic anemia



Nuclear maturation: takes about 3 weeks



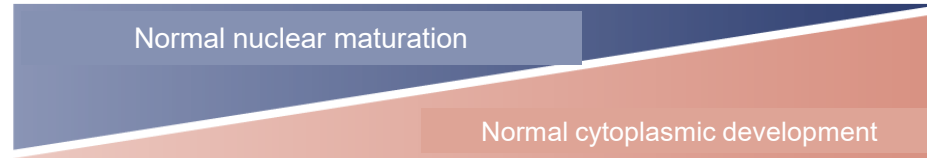
Normocytic

Maturation time = normal
Cytoplasmic development = normal

Microcytic

Maturation time = normal
Cytoplasmic development = impaired

Nuclear maturation: takes about 3 weeks

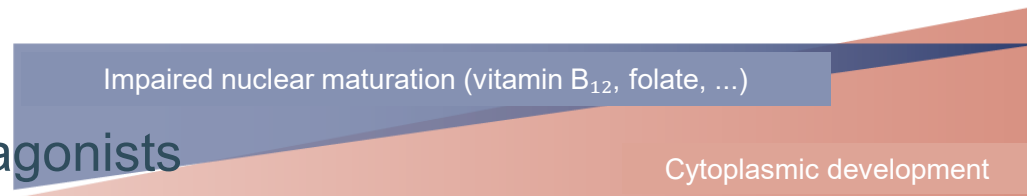


Normocytic

Maturation time = normal
Cytoplasmic development = normal

- DNA metabolism of the maturing erythrocyte

- Vit B₁₂
- Folic acid
- Chemotherapy, folinic acid antagonists

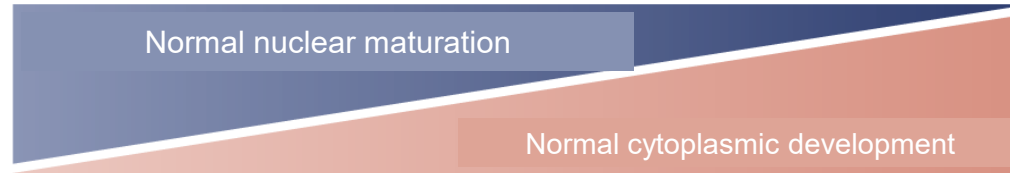


Macrocytic

Maturation time = prolonged
Cytoplasmic development = prolonged

- Impaired nuclear maturation prolongs erythrocyte production and cytoplasmic maturation, increasing MCV
- Other causes of ↑ MCV (influence on maturation time (??))
 - Alcohol misuse
 - Liver disease
 - Hypothyroidism
 - Myelodysplastic neoplasms (see below)

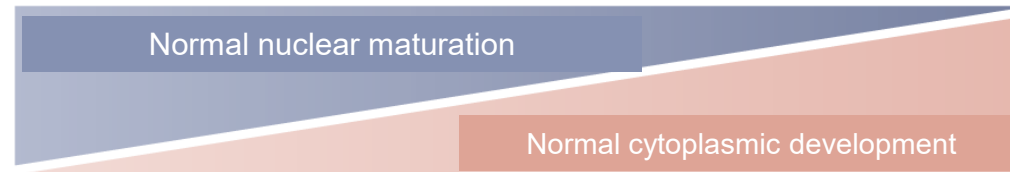
Other causes of impaired erythropoiesis



Normocytic

Maturation time = normal
Cytoplasmic development = normal

- Anemia of chronic disease
- Erythropoietin deficiency (kidney failure)
- Cancer
- Hormonal influences
- **Mostly normocytic, normochromic to hypochromic**

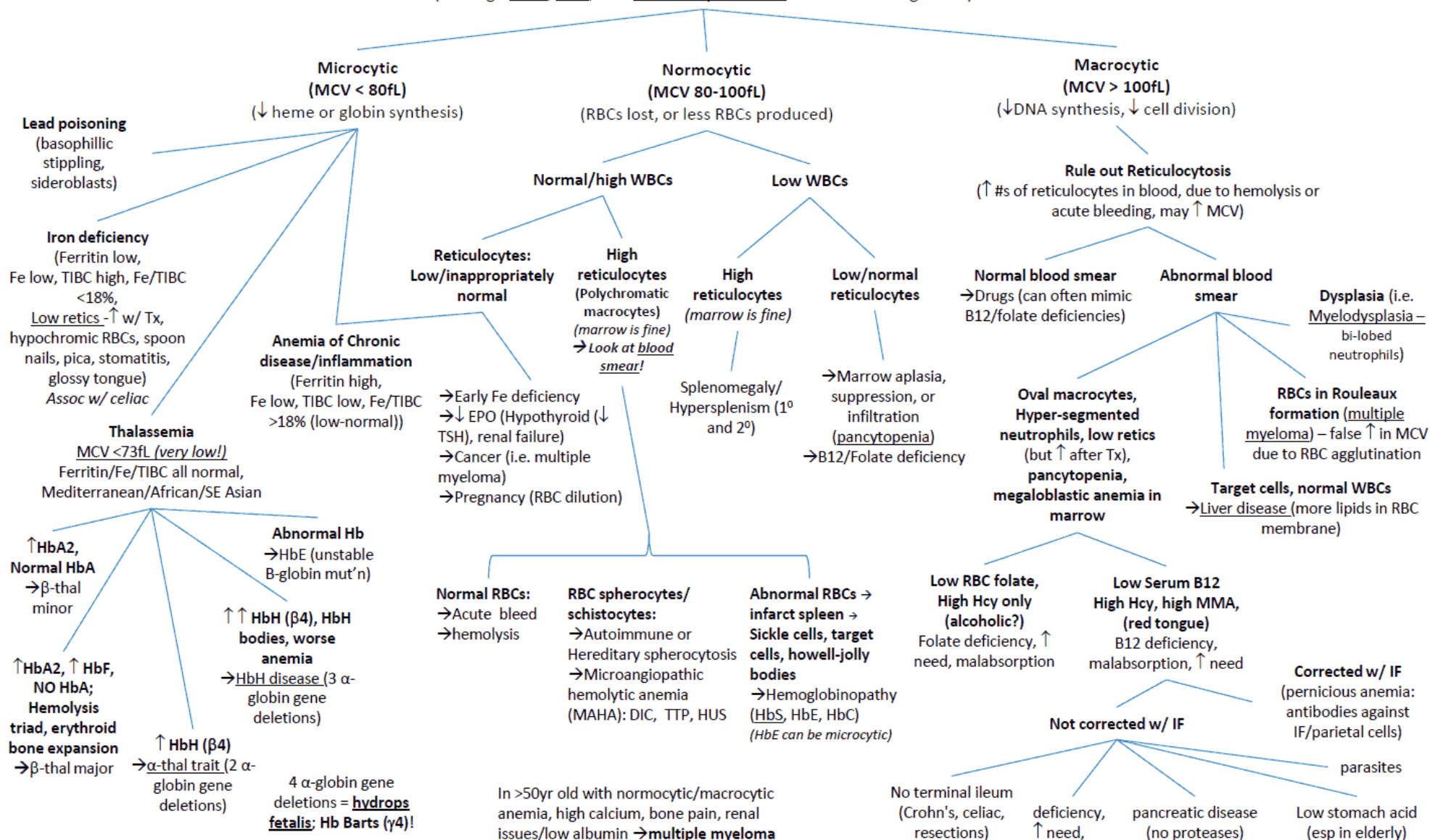


Non-specific suppression
of erythropoiesis

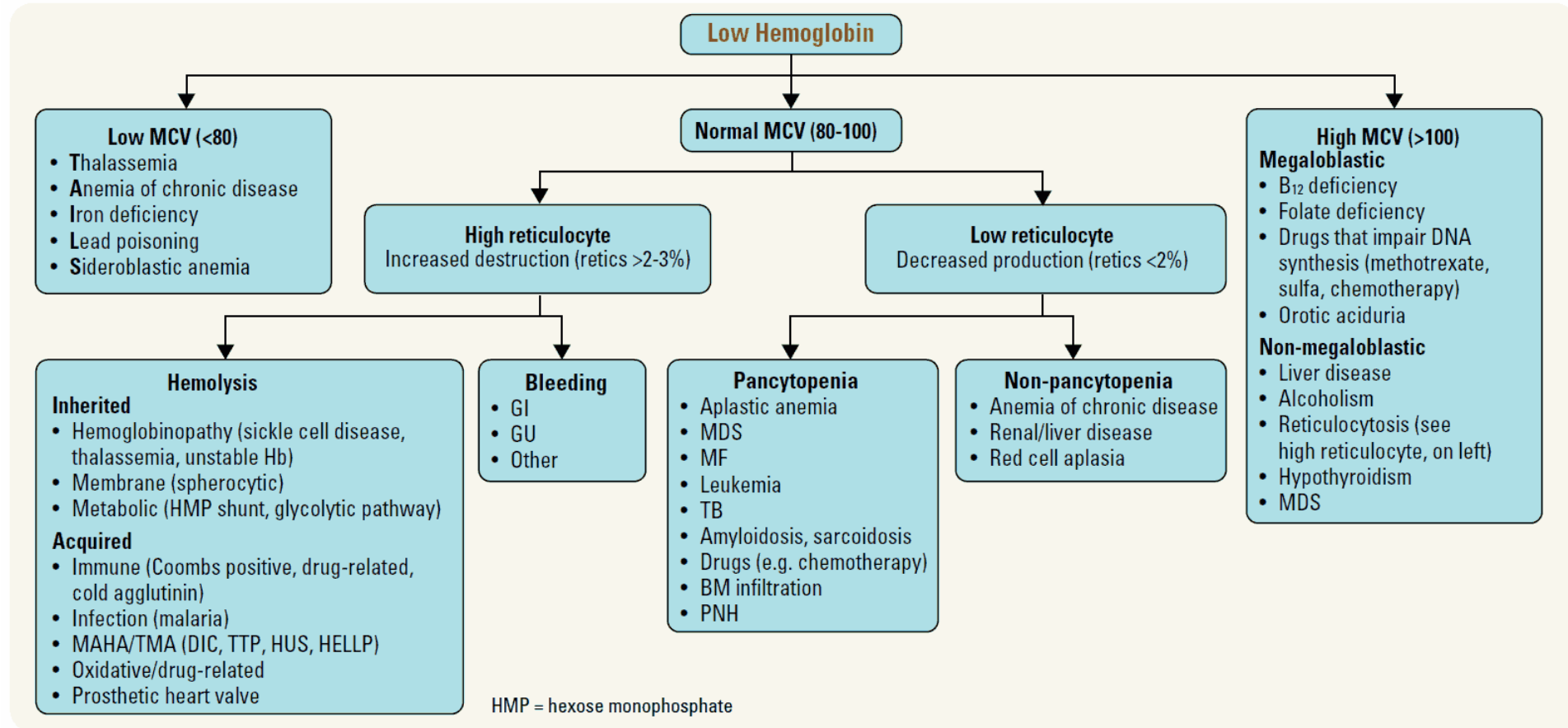
Maturation time = normal
Cytoplasmic development = normal

Anemia

(Average MCV, CBC, and reticulocyte count assists with diagnosis!)



Diagnostic approach to anemia

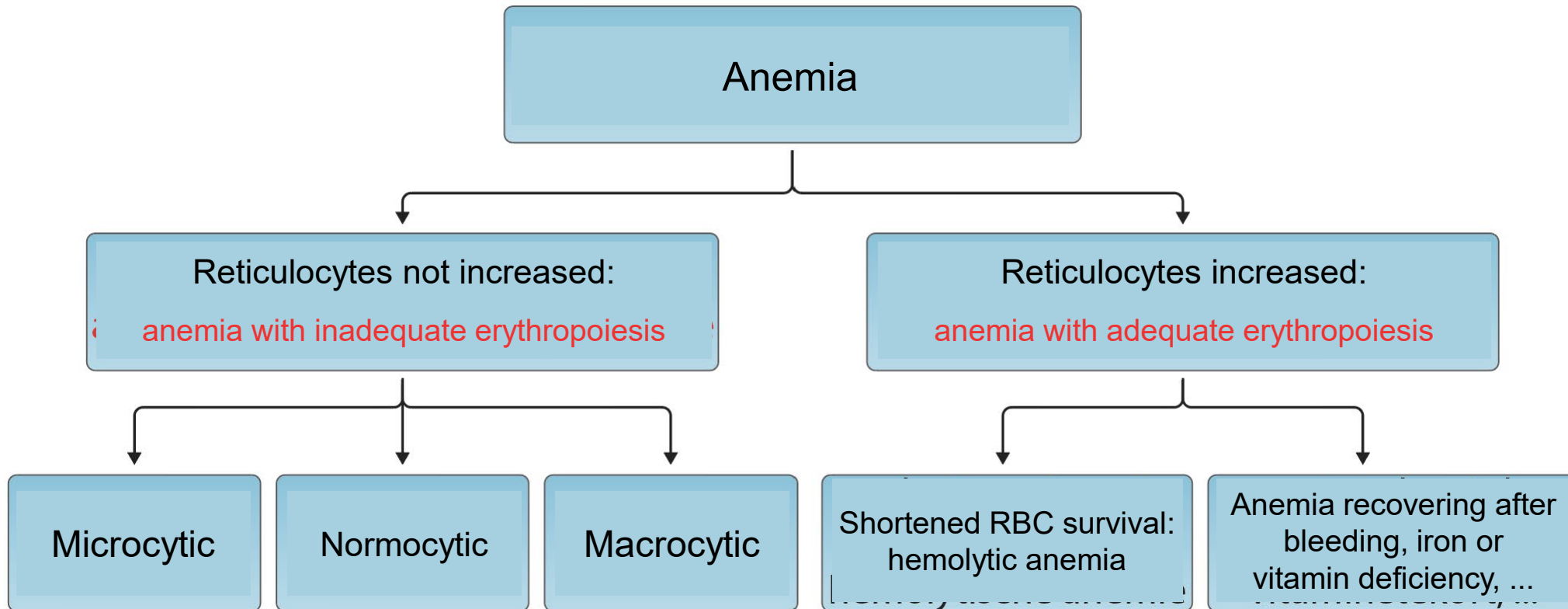


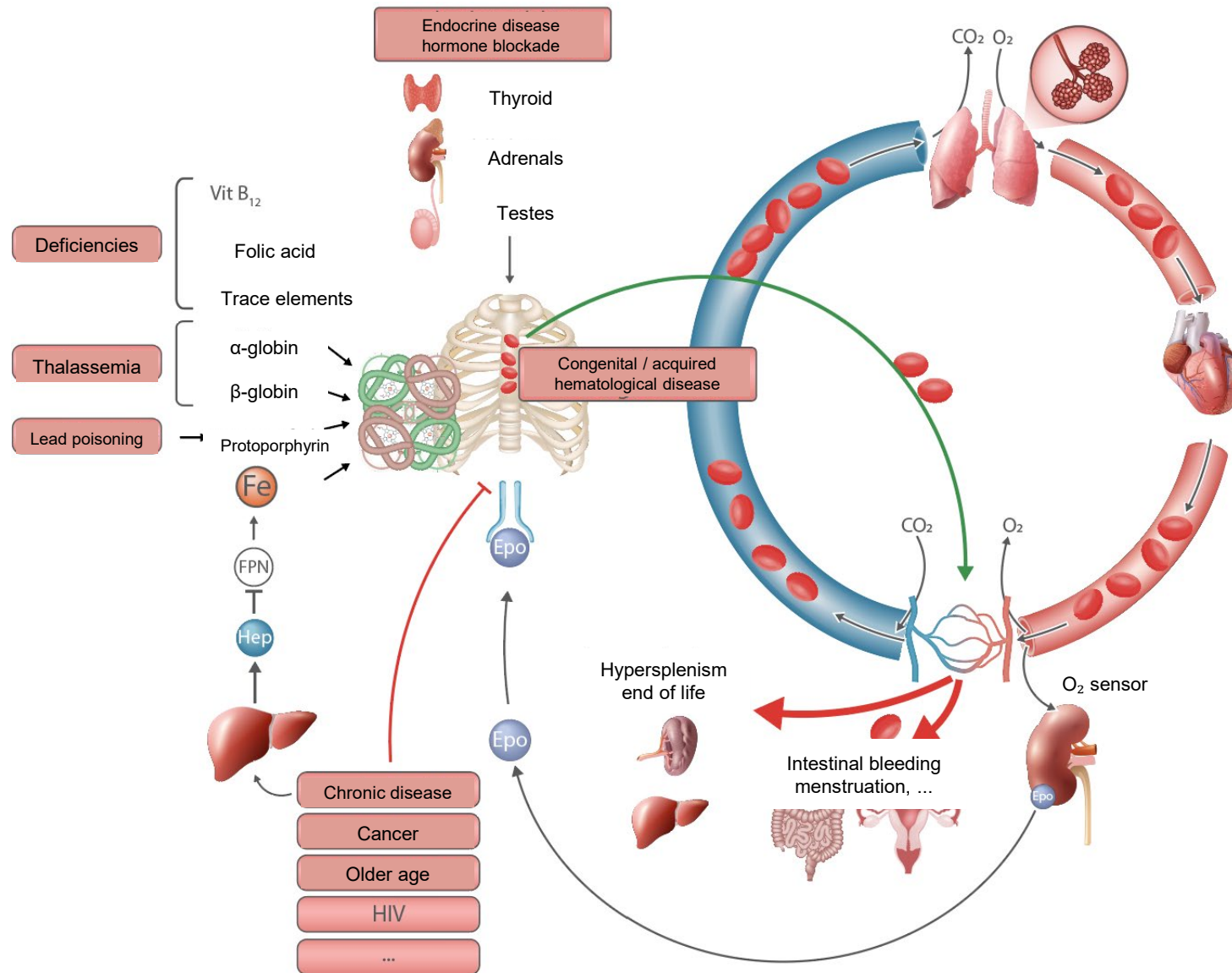
Approach to anemia – classification by MCV

Source: Toronto Notes 2021

Diagnostic approach to anemia

- CBC + **absolute (!)** reticulocyte count



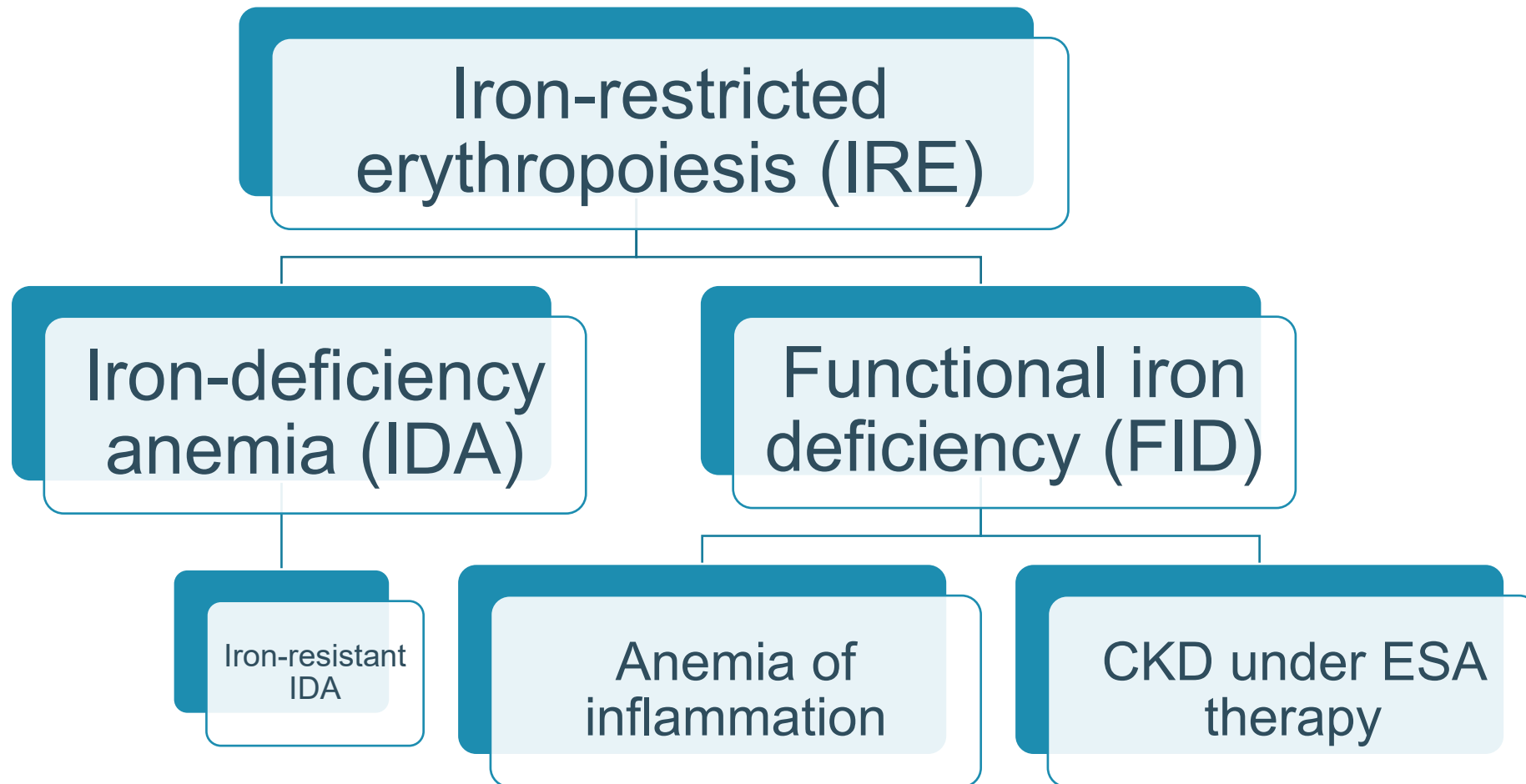


IDA versus ACD

	Iron deficiency	ACD	
Hemoglobin	↓	↓	
MCV/MCH	↓ (in proportion to depth of anemia)	MCV normal (MCHC =/limited ↓) *	
serum iron	↓	↓	
Total iron binding capacity transferrin &	↑	↓	
Ferritin	↓ (30 µg/L)	= or ↑	
Transferrin saturation	< 20%	>20 %	
Iron in macrophages in bone marrow	absent	present	
Iron in erythroblasts in bone marrow	absent	absent	

* In ACD, anemia is normochromic and normocytic to mildly hypochromic and microcytic

& Transferrin binds iron in the serum and thus determines the total iron binding capacity (the total amount of iron that serum proteins can bind)



Glossary

- **Iron-restricted erythropoiesis**
 - A reduced supply of iron for the purpose of erythropoiesis, regardless of the level of iron stores, which are usually replete
- **Iron deficiency**
 - Depressed levels of total body iron, especially iron stores, with preservation of levels of erythroid iron.
- **Iron-deficiency anemia**
 - Depressed levels of total body iron in the presence of anemia.
 - Usually due to loss of iron (bleeding)
 - Very rarely **Iron-refractory iron-deficiency anemia (IRIDA)**
- **Anemia of chronic disorders or anemia of inflammation**
 - Multifactorial anemia associated with increased cytokine production, up-regulation of hepcidin, and abnormal iron homeostasis
- **Functional iron deficiency**
 - Insufficient mobilization of erythroid iron in the presence of increased requests, as occurs after treatment with erythropoiesis-stimulating agents

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Women						> 12
Mean corpuscular volume — fl	Normal	Normal	< 80	Very low	Low-normal	80–95
Mean corpuscular hemoglobin — pg	Normal	Normal	< 27	Very low	Low-normal	27–34
Proposed						
sTFR — mg/liter§	High	High	High	High	Low-normal	Varies¶
sTFR/log ferritin index	NA	NA	> 2	NA	< 1	Varies¶
Hepcidin	Low	Low	Very low	Normal-high	High	Varies¶
Zinc protoporphyrin**	Normal	High	High	High	High	Varies¶
Reticulocyte hemoglobin content — pg††	< 25	< 29	Low	Low	Low	31.2 ± 1.6
Perl's staining of bone marrow for iron	Negative	Variable	Negative	Positive	Strongly positive	Positive

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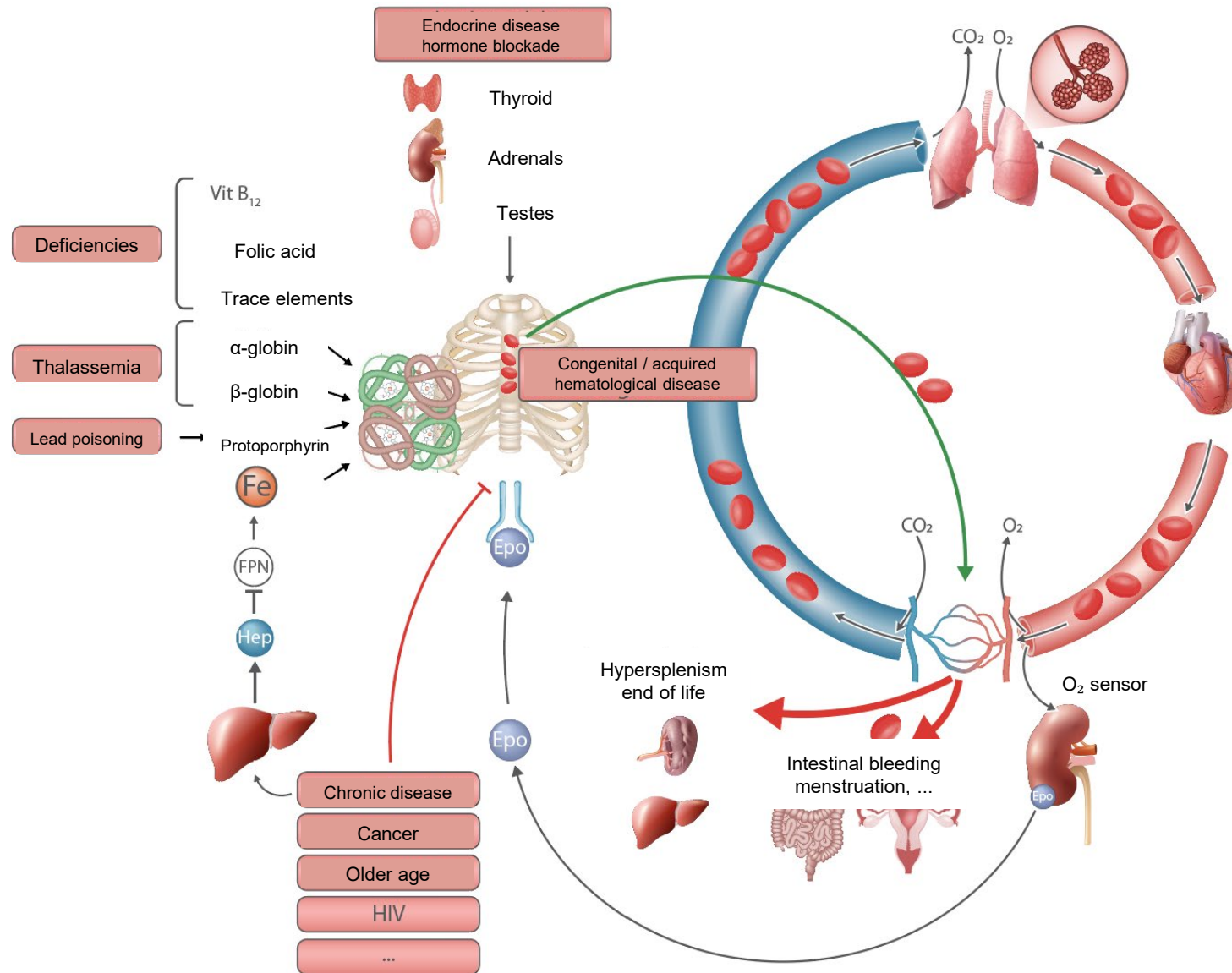
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** The values for zinc protoporphyrin are used only in screening for or monitoring iron-deficiency anemia.⁹

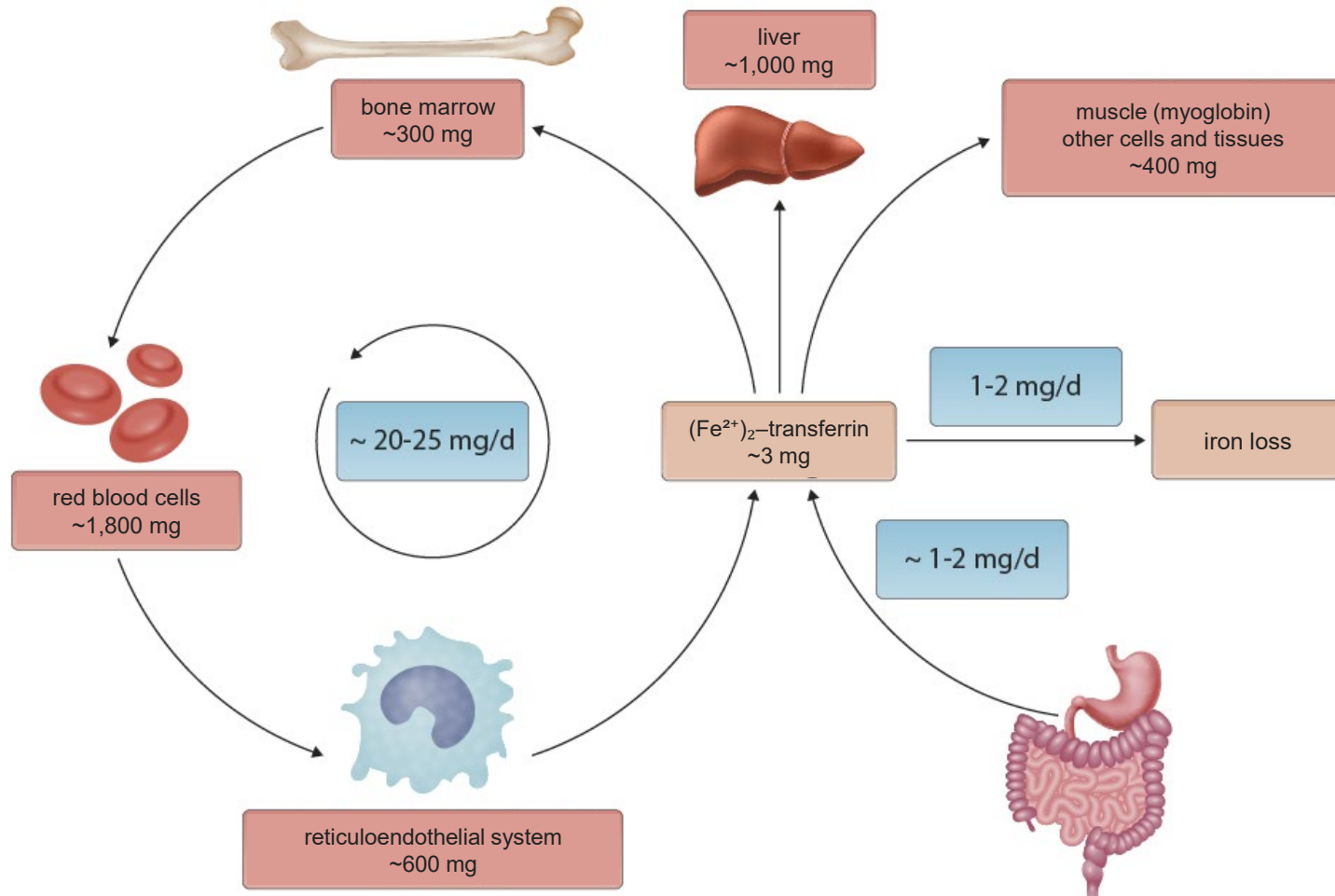
†† Reduction of reticulocyte hemoglobin content is an early sign of functional iron deficiency.⁵²



Anemia in chronic kidney disease (GFR < 60ml/min)

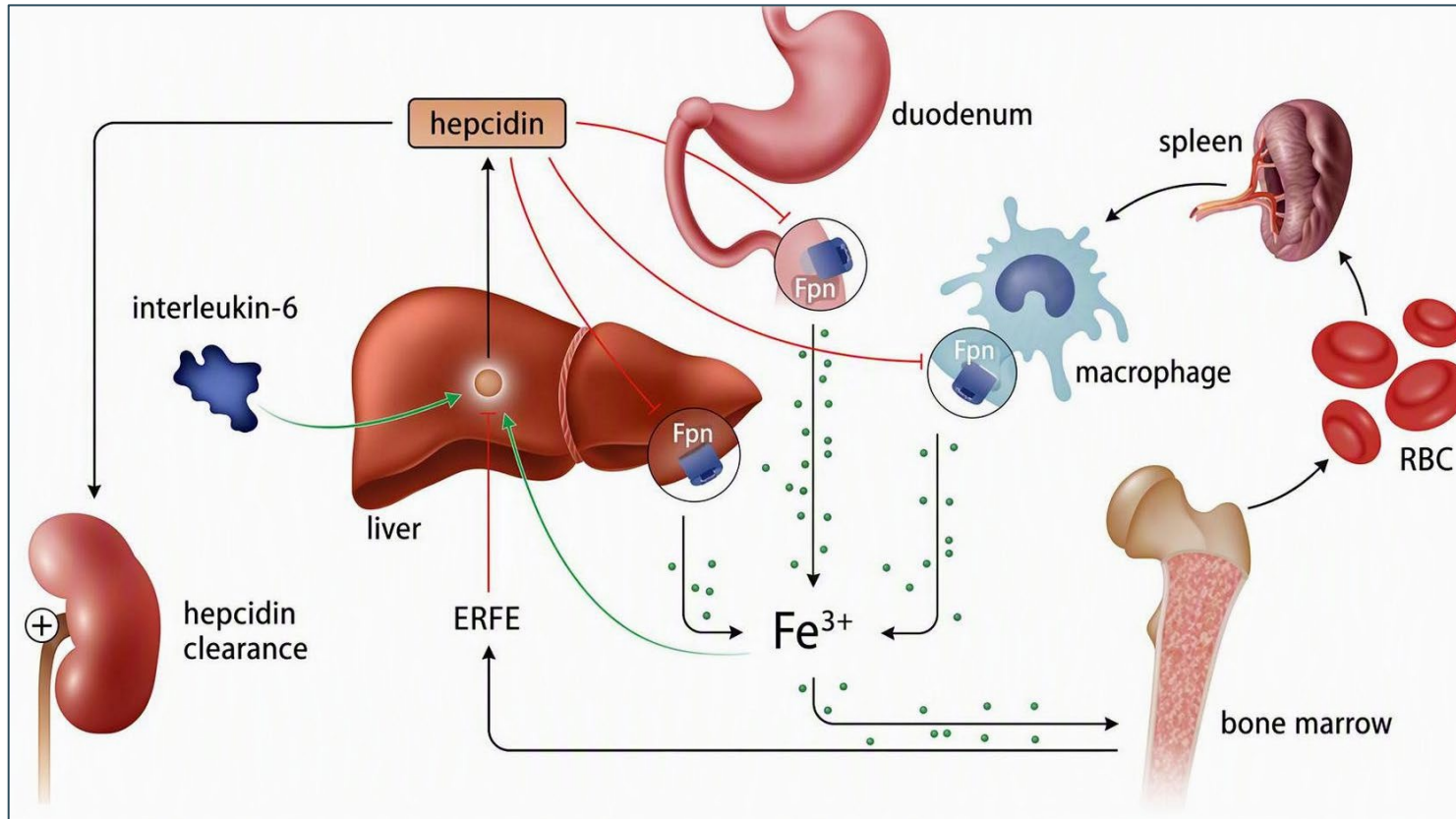
- Reduced production due to
 - Decreased erythropoietin
 - Uremia
 - Iron deficiency
 - Blood loss (uremia, hemodialysis, blood samples, ...)
 - Increased hepcidin (inflammation; moreover, hepcidin is cleared by the kidneys!)
- Shortened RBC survival
- Treatment
 - EPO combined with iron supplementation (oral or IV) – even with normal iron indices (“functional iron deficiency” *stricto sensu*) GFR < 45ml/min)

The iron cycle

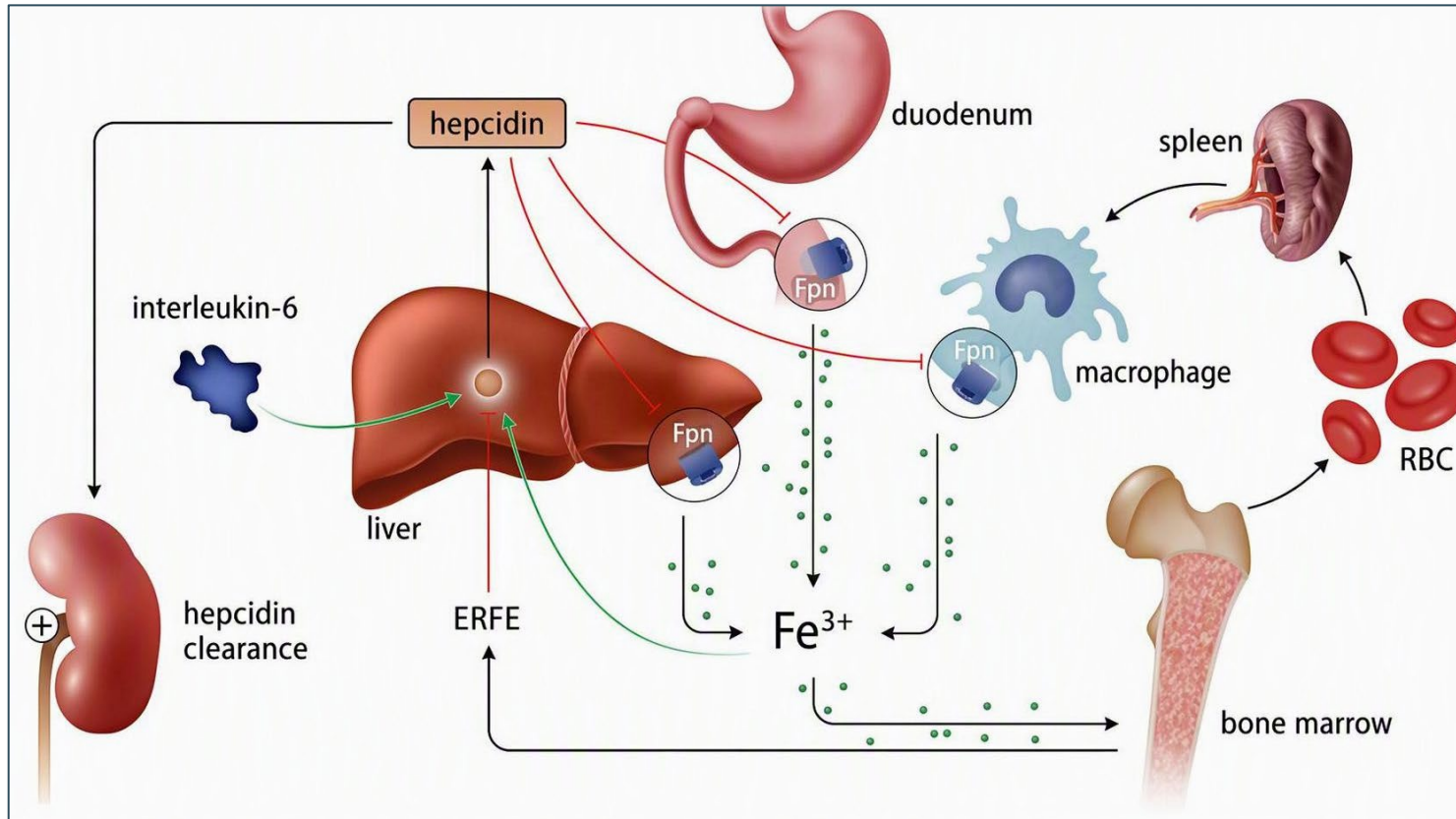


- 3–4 g Fe ($\text{♂} > \text{♀}$), with ~2/3 in the RBC compartment and ~10% in muscle
- Serum transport: transferrin
- Daily iron turnover: 20–25 mg/day
 - 1–2 mg/day intestinal absorption
 - 20–25 mg/day RES recycling
 - Stores: ferritin and hemosiderin in the RES
- Iron absorption depends on iron deficiency and the rate of erythropoiesis
- No regulated excretion of excess iron

Hepcidin, master regulator of available serum iron



Hepcidin, master regulator of available serum iron



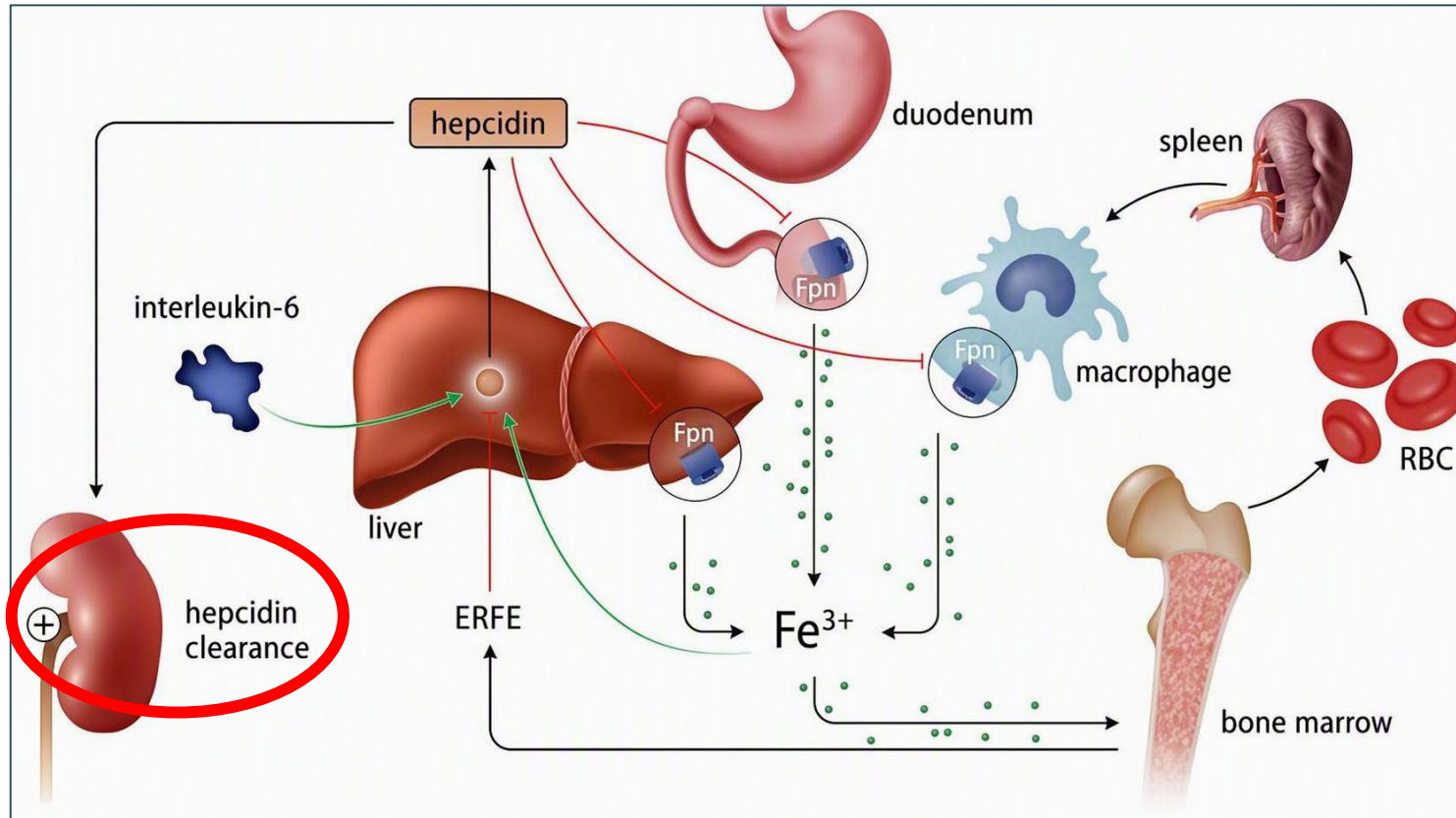
- Inflammation – IL6

- Hepcidin $\uparrow\uparrow$



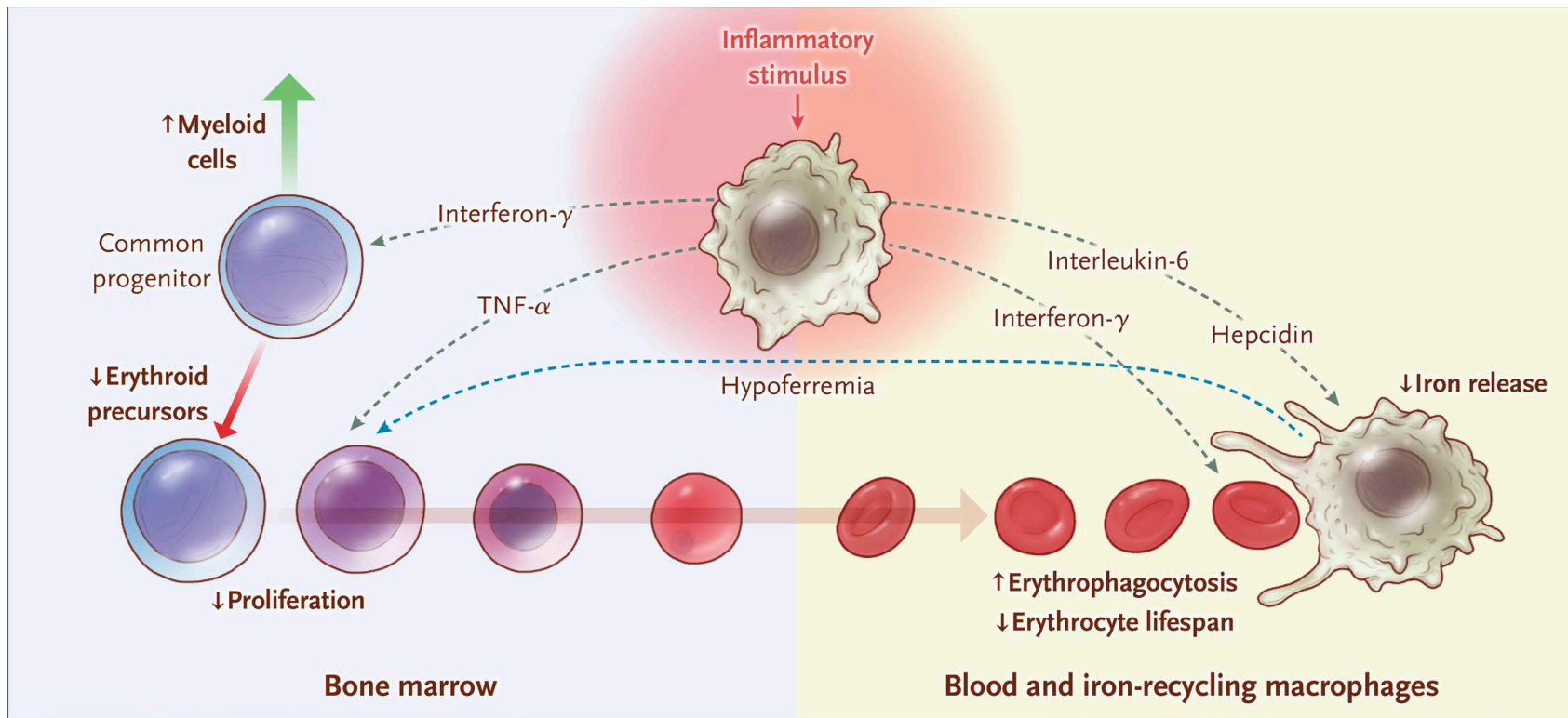
- Decreased iron absorption and recruitment from iron stores: protection against bacterial infections

Hepcidin, master regulator of available serum iron



- Inflammation – IL6
 - Hepcidin ↑↑
- ↓
- Decreased iron absorption and recruitment from iron stores: protection against bacterial infections
 - ERFE: erythroferrone

Anemia of inflammation/anemia of chronic disease (ACD)



Shift to granulopoiesis
Decreased erythropoiesis
cytokines
↓ iron
Shortened RBC survival
Erythrophagocytosis

Anemia of inflammation/anemia of chronic disease (ACD)

- Definition
 - Mild to moderate anemia (hemoglobin 7 to 12 /dL) in the context of systemic inflammation, due to
 - normochromic – normocytic anemia
- Epidemiology:
 - Together with iron deficiency anemia, the most common form of anemia worldwide

Anemia of inflammation/anemia of chronic disease (ACD)

- Typically associated with
 - Systemic diseases (rheumatoid arthritis, systemic lupus erythematosus, ...)
 - Inflammatory bowel disease
 - Chronic infections, including TB and HIV
 - Malignancies with B symptoms (HL, NHL, Castleman disease)
- Also contributes to
 - Anemia in chronic kidney failure
 - Anemia in chronic heart failure

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Anemia of inflammation/anemia of chronic disease (ACD): the challenge

- Often elderly patients with several comorbidities
- Identify those with concomitant iron-deficiency anemia
 - Antiaggregants, anticoagulation
 - Frequent blood sampling
 - Recent surgery, bleeding, ...?
 - iFob?

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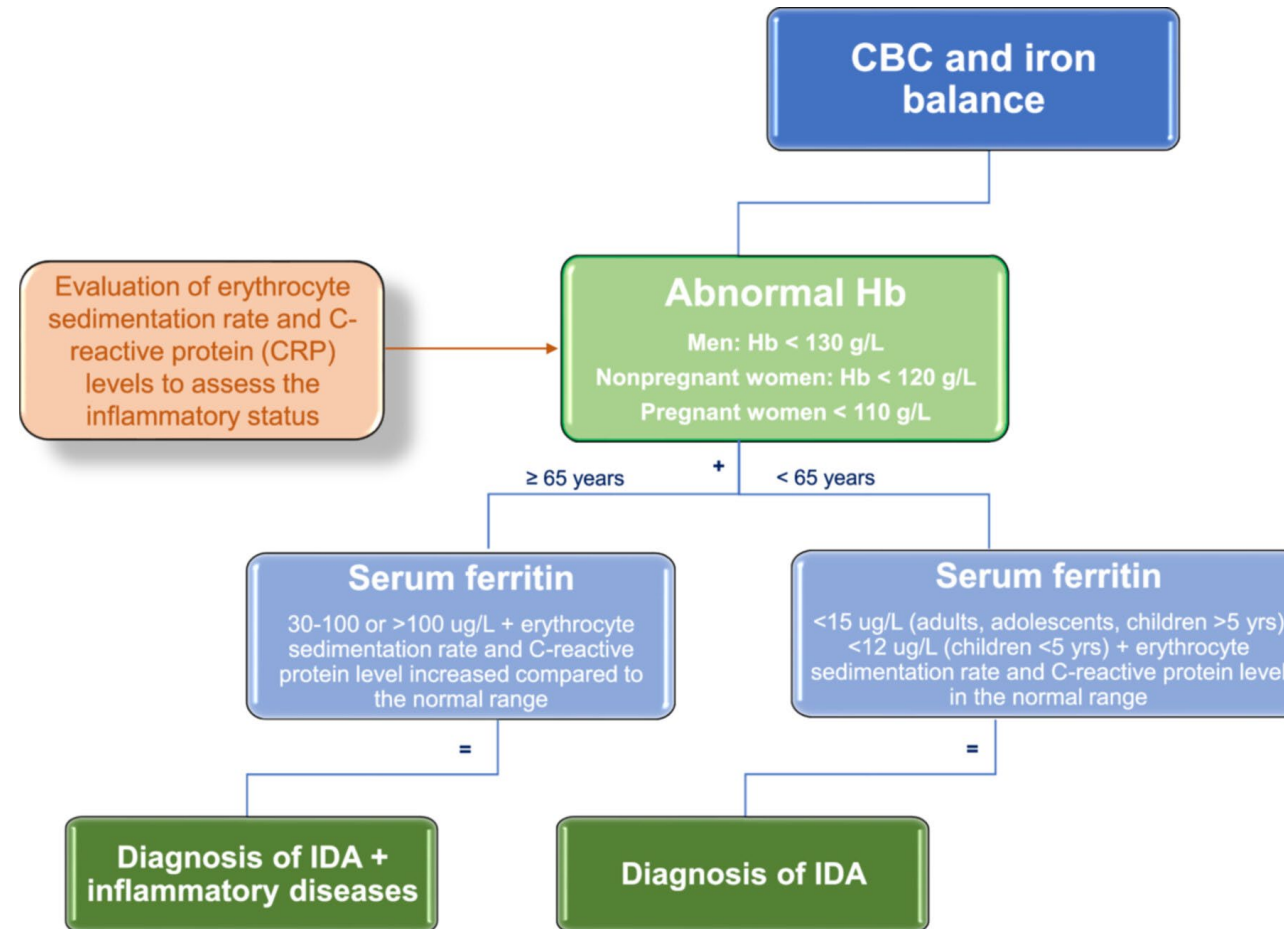
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Recommendations for diagnosis, treatment, and prevention of iron deficiency and iron deficiency anemia



Specific contexts

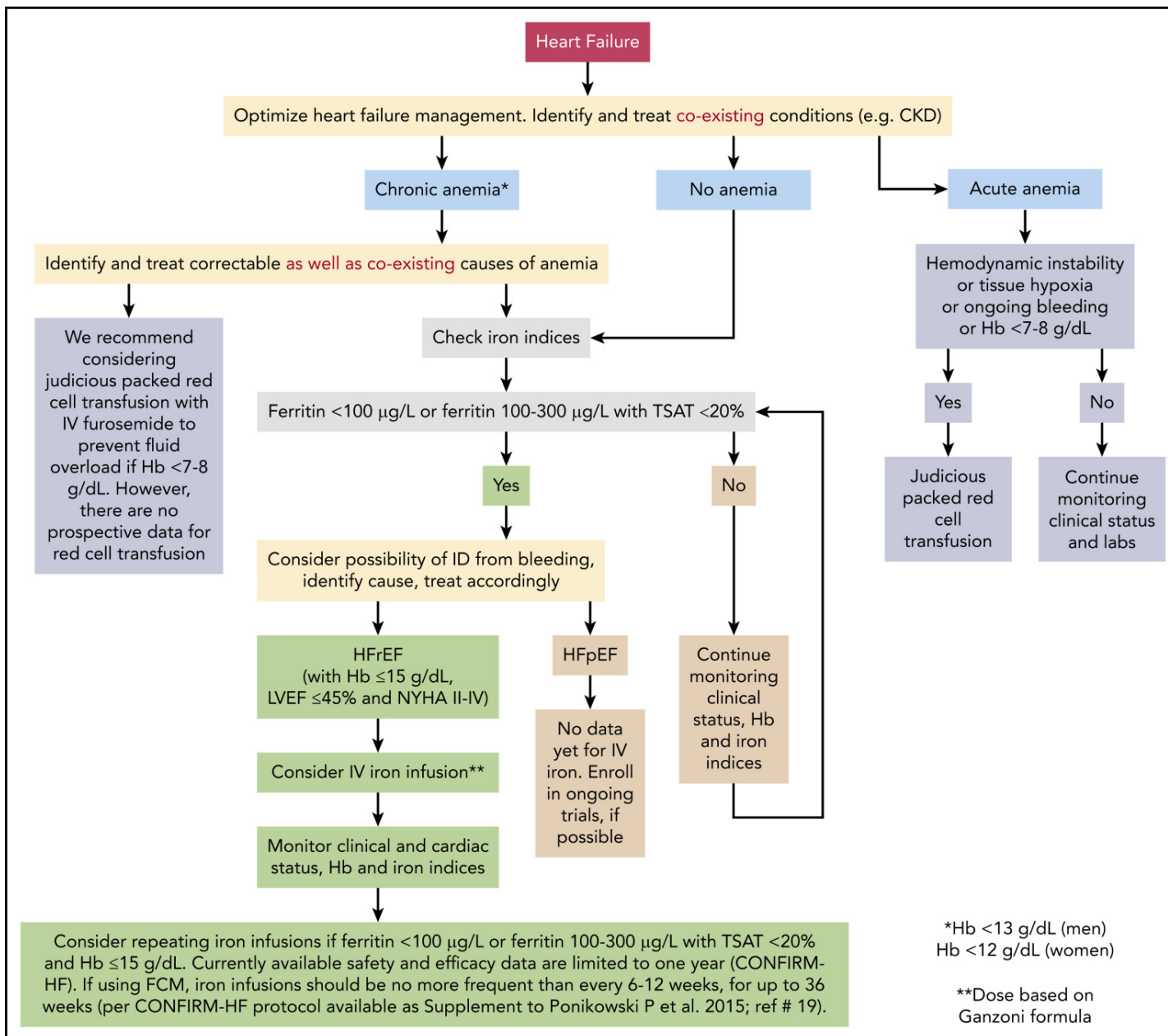
- Anemia in endocrine diseases
 - Pituitary insufficiency
 - Thyroid dysfunction (Hypo: MCV $-/\uparrow$; Hyper: MCV $-/\downarrow$)
 - Adrenal insufficiency
 - Hypogonadism (antiandrogens in prostate carcinoma?)
 - Therapy: endocrinological treatment
 - Anemia in malnutrition/anorexia nervosa/
after bariatric surgery: often multifactorial
 - Anemia of cancer
 - Anemia in the elderly patient
 - Anemia in HIV infection
- or a subset pattern of anemia or chronic disease, in combination with other factors ?

Anemia in cancer

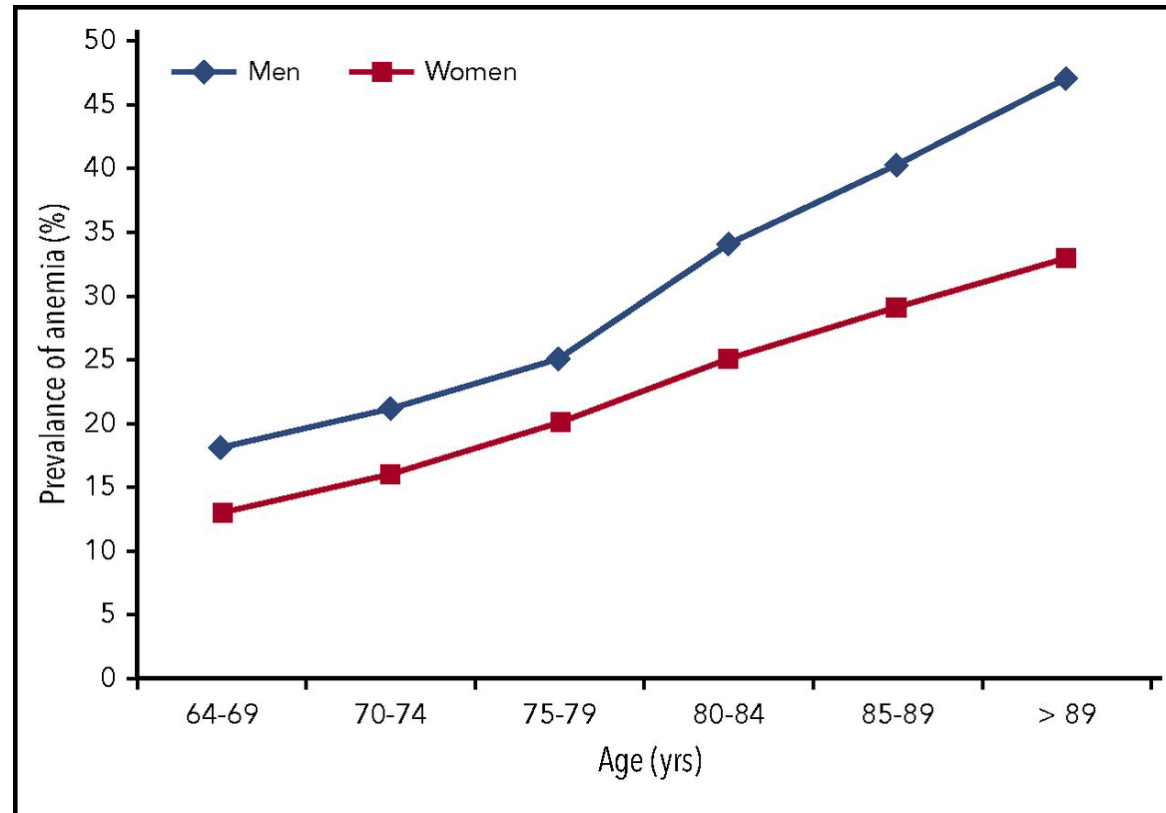
- Before or at diagnosis
 - Iron deficiency (occult gastrointestinal blood loss)
 - Anemia of chronic disease (inflammatory status, cancer cachexia, nutritional deficiency, metastases in liver or lungs)
 - Bone marrow damage
 - Bone marrow invasion by non-hematologic or hematologic malignancy ("myelophthisis", crowding)
 - Intrinsic hematopoietic failure (myelodysplastic syndromes)
- After diagnosis: additional effect of negative impact of treatment
 - Frequent sampling
 - Chemotherapy
 - Radiation
 - Nutritional

Iron deficiency and IDA/AI in heart failure

- Iron is also an essential compound for mitochondrial function
- In patients with HF, ID, with or without anemia,
 - reduces QOL and exercise capacity
 - Increases mortality
- Correction of ID and IDA in HFrEF with iv iron have become standard in HFrEF: sole indication for iv iron in ID without anemia
 - ESA associated with higher rate of thrombotic events



Anemia at older age: prevalence



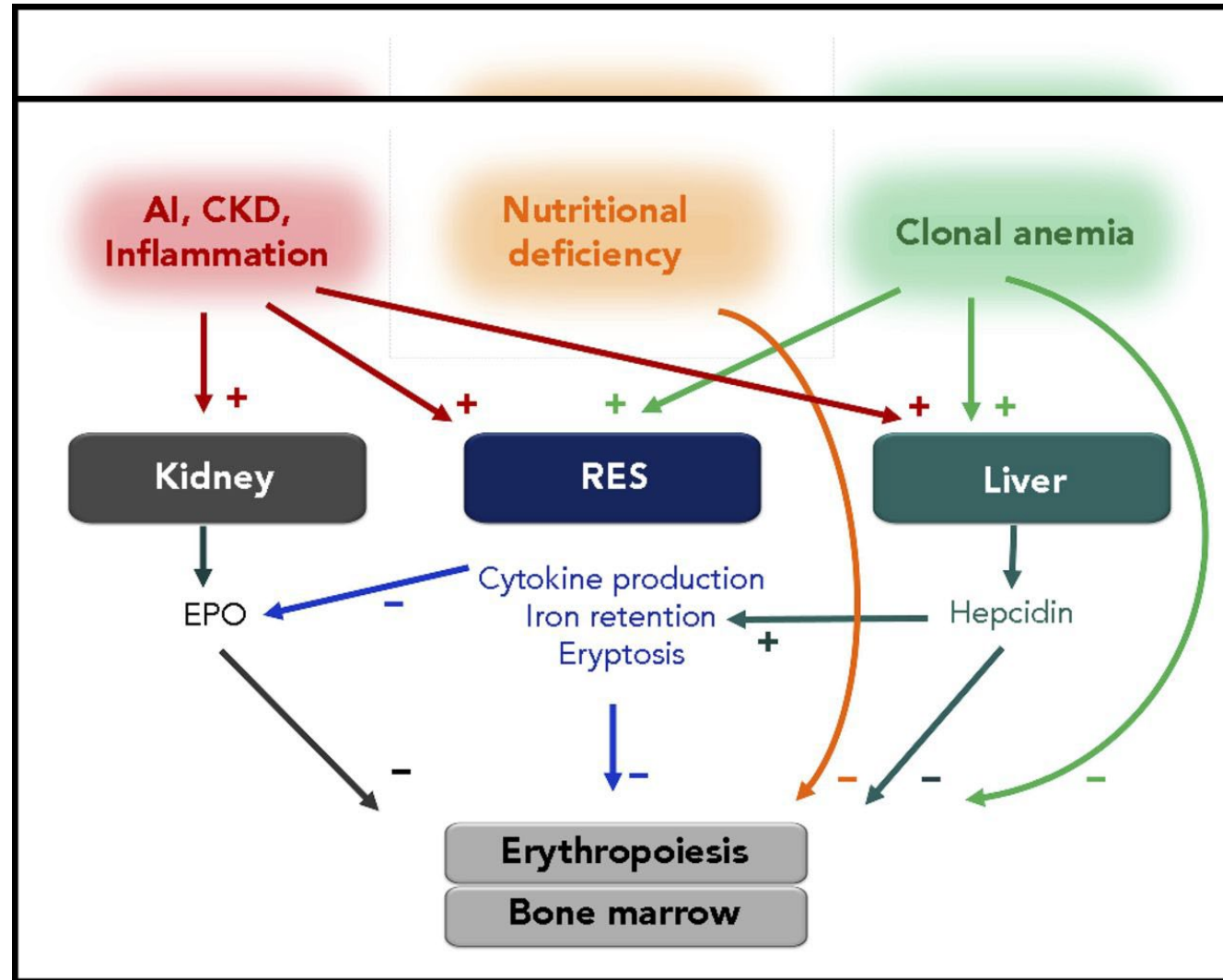
Anemia at older age: highly relevant

Table 1. Association between anemia in older adults and adverse clinical outcome based on large prospective studies

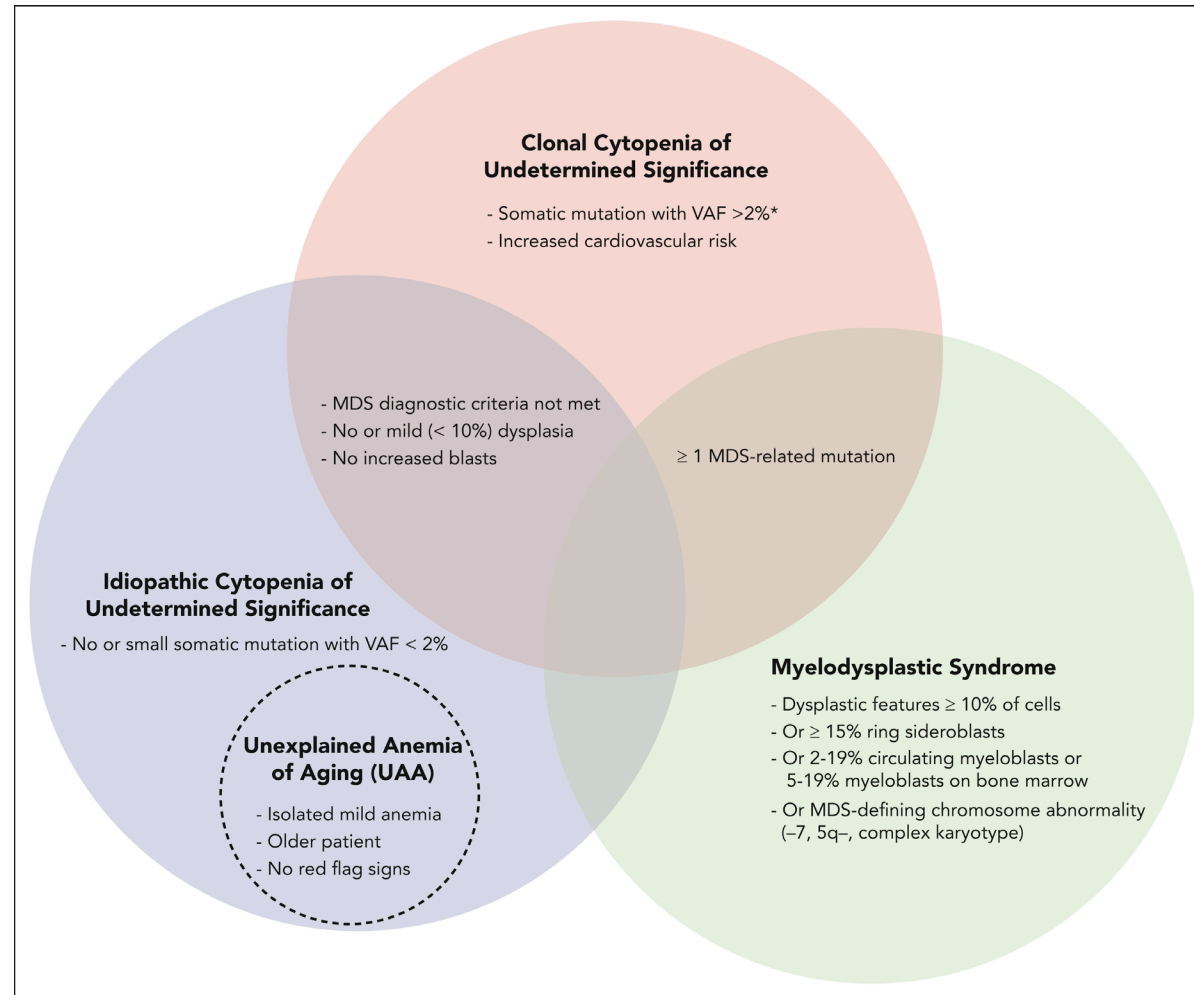
Study name	Study population	Reference	Finding/comments
NHANES III Study (National Health & Nutrition Examination Survey)	Noninstitutionalized US population ≥ 65 y from third NHANES (1988-1994)	11	Significant negative impact of anemia on OS (RR of 1.8; $P < .001$). Differential impact of subtypes of anemia: nutritional (RR of 2.34, $P < .0001$), CKD (1.70, $P < .0001$), chronic inflammation (1.48, $P < .0001$), UA (1.26, $P < .01$).
Health and Anemia Study (Salute e Anemia)	Observational study of all 65- to 84-y-old residents (N = 10 110); Biella, Piedmont, Italy	19	Mild-grade anemia (F: 10.0-11.9 g/dL; M: 10.0-12.9 g/dL) independently associated with poorer cognition, function, mood, and QoL (uni- and multivariate analysis adjusted for comorbidities, age, and sex).
InCHIANTI (Invecchiare in Chianti, "Aging in the Chianti Area")	Population-based study; Tuscany region, Italy	23 22	Anemia is associated with disability, poorer physical performance, and lower muscle strength (even in adjusted analyses including comorbidities, renal function, and inflammatory markers). Anemia is associated with a significantly higher risk of depressive symptoms after adjusting with potential confounders (OR = 1.93; 95% confidence interval [CI], 1.19-3.13).
Leiden 85-Plus Study	Population-based prospective study; Leiden, The Netherlands	24	Prevalent anemia and incident anemia were both associated with an increased mortality, even after adjustment (hazard ratio [HR] for prevalent anemia, 1.41; 95% CI, 1.13-1.76; HR for incident anemia, 2.08; 95% CI, 1.60-2.70).
Health, Aging, and Body Composition Study (Health ABC)	Prospective cohort 3075 community-dwelling white and black older adults 70-79 y from Memphis, Tennessee, or Pittsburgh, Pennsylvania; beginning in 1997	20	Baseline anemia had an increased risk for dementia (23% vs 17%; HR, 1.64; 95% CI, 1.30-2.07) in unadjusted analysis. Remains significant in adjusted analyses (for comorbidities, MCV, renal function, CRP, etc).
Cardiovascular Health Study	Prospective cohort study with 11.2 y of follow-up of 5888 community-dwelling men and women 65 y or older, enrolled in 1989-1990 or 1992-1993 in 4 US communities	14 31	Anemia as per WHO criteria was independently associated with increased mortality. After multivariate adjustment, HR for mortality was 1.33 (95% CI, 1.15-1.54). Hb decline was associated with subsequently poorer cognitive function in men and anemia development with poorer cognitive function in women. Both anemia development (HR, 1.39; 95% CI, 1.15-1.69) and Hb decline (HR, 1.11; 95% CI, 1.04-1.18 per 1 g/dL decrease) predicted subsequent mortality.

CRP, C-reactive protein; F, female; M, male; MCV, mean corpuscular volume; OR, odds ratio; OS, overall survival; RR, relative risk.

Anemia at older age: etiologies



Anemia at older age



Anemia of chronic disease: therapy

- Underlying disease
- In elderly, multiple comorbidities may coexist: CKD, HF, inflammaging
- Consider coexistence of IDA
 - Medication: antiaggregants, anticoagulation
 - iFOB as screen is controversial
 - Iatrogenic (surgery?, blood sampling ...)
- Ferritin < 100 or even more , TSAT <20

Anemia of chronic disease: therapy

- Underlying disease
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Table 2. Compounds under Development for the Treatment of Anemia of Inflammation.

Compound	Target*	Stage of Development (Study)
Heparin derivatives	BMPs that stimulate hepcidin synthesis	Preclinical stage (Poli et al. ⁵⁷)
Soluble hemojuvelin	BMPs that stimulate hepcidin synthesis	Preclinical stage (Theurl et al. ⁵⁸)
Engineered hepcidin binders	Hepcidin	Preclinical stage (Hohlbaum et al. ⁵⁹) and phase 1 (Boyce et al. ⁶⁰)
Monoclonal antibodies	Ferroportin, blocking hepcidin access	Phase 1 (Sheetz et al. ⁶¹)
	BMP-6	Phase 1 (Sheetz et al. ⁶¹)
	Hepcidin	Phase 1 (Vadhan-Raj et al. ⁶²) and preclinical stage (Sasu et al. ⁶³)
	Hemojuvelin	Preclinical stage (Kovac et al. ⁶⁴)
Momelotinib	BMP receptor (ACVR1) and JAK1 and JAK2	Preclinical stage (Asshoff et al. ⁶⁵) and phase 3 (Mesa et al. ⁶⁶)†
TP-0184	BMP receptor (ACVR1)	Phase 1 (Peterson et al. ⁶⁷)
Prolyl hydroxylase inhibitors	HIF prolyl hydroxylases	Preclinical stage (Barrett et al. ⁶⁸) and phase 2 (Chen et al. ⁶⁹)‡

* ACVR1 denotes activin A receptor 1, BMP bone morphogenetic protein, HIF hypoxia-inducible factor, and JAK1 and JAK2 Janus kinase 1 and 2, respectively.

† The phase 3 study involved patients with myelofibrosis.

‡ The phase 2 study involved patients with chronic kidney disease.

↓ hepcidin

↑ EPO

IDA versus ACD/IA versus thalassemia trait

Iron deficiency anemia, anemia of chronic disease and thalassemia minor

	Iron deficiency	ACD	Thalassemia minor (α/β)
hemoglobin	↓	↓	↓
MCV/MCH	↓ (proportional to anemia severity)	Normal (or slightly ↓) *	↓↓ (disproportionate to anemia severity)
serum iron	■	■	=
Total iron-binding capacity (transferrin) &	↑	↓	=
ferritin	↓	= or ↑	=
Iron in bone marrow macrophages	absent	present	present
Iron in bone marrow erythroblasts	absent	absent	present

* In ACD, anemia is normochromic and normocytic to mildly hypochromic and microcytic

& Transferrin binds iron in the serum and thus determines the total iron binding capacity (the total amount of iron that serum proteins can bind)

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M, 78 y

- 1990's: FL, autologous stem cell transplantation, CR
- 2010: relapse, W&W
- Atrial Fibrillation
- 2019: R-Bendamustine 6x, CR
- 3/2022. Covid-pneumonia, ICU 3x
- 7/2022: overwhelming pneumonia (pseudomonas)
- 2ndary hypogammaglobulinemia, monthly IVIG
- Low CD4 count

Therapy

- atorvastatin
- Bisoprolol
- Eusaprim-trimethoprim 3x/w
- Lixiana
- Omeprazole

Entiteit	Eenheid	Referentie	06-11-2024 09:23	28-10-2024 09:25	24-10-2024 00:00	09-10-2024 08:00	24-09-2024 14:04
HEMATOLOGIE							
+ Hemoglobine	g/dL	Zie dagrapport	7.6	8.5	7.7	8.7	9.7
+ Hematocriet		Zie dagrapport	0.244	0.281	0.240	0.276	0.310
+ RBC telling	10**12/L	Zie dagrapport	2.84	3.22		3.24	3.6
+ MCV	fL	Zie dagrapport	85.9	87.3	83.6	85.2	86.2
+ MCH	pg	Zie dagrapport	26.8	26.4	26.8	26.9	27.2
+ MCHC	g/dL	Zie dagrapport	31.1	30.2	32.1	31.5	31.6
RDW	%	11.7 - 14.5	15.9	16.3		16.9	
+ Reticulocyten	10**9/L	Zie dagrapport	31	32	30.7	54	33.1
Immat. Retic	%	5.0 - 21.0	11.5	10.1		19.0	
+ Erytroblasten	/ 100 WBC	Zie dagrapport	0.00	0.00		0.00	0.0
+ WBC telling	10**9/L	Zie dagrapport	3.13	3.40	2.6	2.58	2.6
+ Bloedplaatjes	10**9/L	Zie dagrapport	205	220	140	193	163
+ MPV	fL	Zie dagrapport	11.5	10.7		12.1	11.7
- WBC differentiatie							
Aantal gediff. WBC				100			
Neutr. segm - micr	%	39.2 - 72.9			63.9		
Imm. Granulocyt.	%	≤ 1.0	0.3	0.3		0.8	
Neutrofielen	%	38.0 - 77.0	68.4	63.9		60.8	
+ Eosinofielen	%	Zie dagrapport	2.2	2.6	2.0	2.3	
+ Basofielen	%	Zie dagrapport	1.0	1.2	0.8	1.6	
+ Lymfocyten	%	Zie dagrapport	17.6	18.8	19.6	20.5	
+ Monocyten	%	Zie dagrapport	10.5	13.2	13.7	14.0	
- Stolling							
PT (%)	%	≥ 70					79
PT (INR)	INR	≤ 1.2					1.2
APTT	s	25.1 - 36.5					35.0
CHEMIE BLOED							
CRP	mg/L	≤ 5.0	15.3	42.4		8.4	
+ Natrium	mmol/L	136.0 - 145.0	140.5	143.3	143	140.0	143
+ Kalium	mmol/L	Zie dagrapport	4.35	4.56	4.39	4.79	5.1
+ Chloride	mmol/L	98.0 - 107.0	104.9	106.2	107	106.0	109
+ Bicarbonaat	mmol/L	Zie dagrapport	24.4	24.6	24	24.1	26
+ Anion gap	mEq/L	Zie dagrapport	15.6	17.1		14.7	13.0
Ureum					<html>Nie...		
+ Creatinine	mg/dL	Zie dagrapport	2.00	1.82	1.56	2.08	1.7
+ eGFR (CKD-EPI)	mL/min/1.73 m**2	Zie dagrapport	31	35	43	30	39
+ Urinezuur	mg/dL	Zie dagrapport		6.6	6.3	7.2	
Totaal eiwit	g/L	66 - 88	66	74		68	
Albumine	g/L	35.0 - 52.0	39.1	41.4		41.2	
Calcium	mmol/L	2.15 - 2.55	2.26	2.41		2.34	
Calcium (albumine correctie)	mmol/L	2.15 - 2.55	2.28	2.38		2.32	
Fosfaat	mmol/L	0.81 - 1.45	1.07	0.87		0.80	
Glucose	mg/dL	55 - 100	124	75		100	
Bilirubine totaal	mg/dL	≤ 1.18	0.23	0.27		0.25	
Bilirubine direct	mg/dL	≤ 0.50	< 0.18				
+ Gamma GT	U/L	Zie dagrapport	101	113	84	108	
+ Alkalische fosfatasen	U/L	Zie dagrapport	177	188	163	138	
+ AST	U/L	Zie dagrapport	28		21		
+ ALT	U/L	Zie dagrapport	18	15	12	14	

- 16/10: stenting of R art iliaca communis,
- 24/10: general practitioner
- 28/10/24: unplanned outpatient clinic visit with fatigue

?

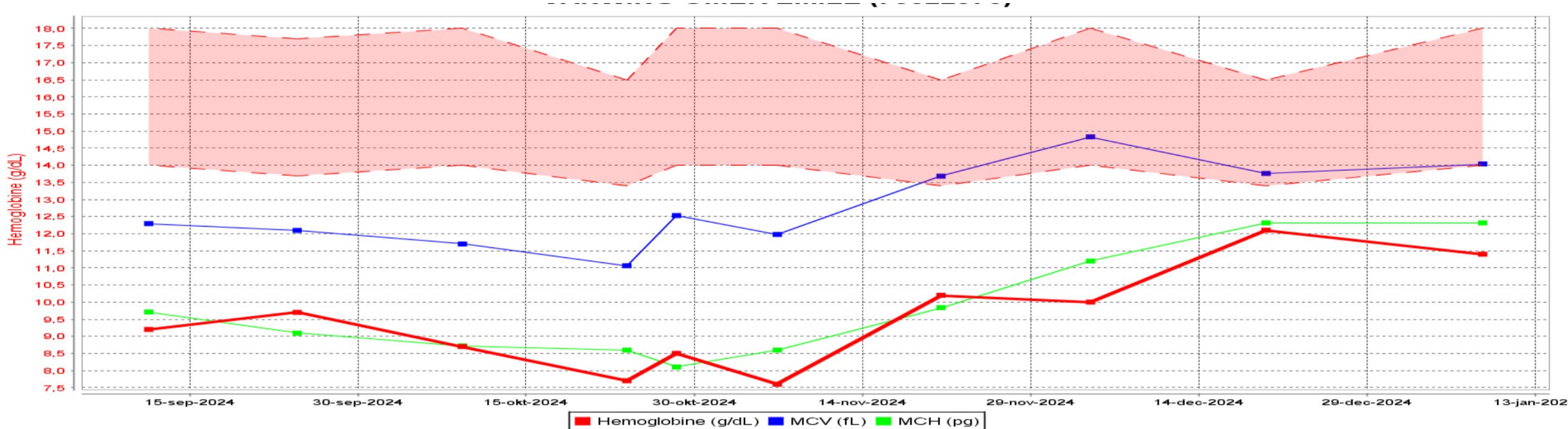
IJzer	30	µg/dL	65 - 175
Transferrine	2.76	g/L	2.00 - 3.60
Transferrine saturatie	8	%	16 - 45
Ferritine	57	µg/L	30 - 400

?

Entiteit	Eenheid	Referentie	08-01-2025 08:00	20-12-2024 00:00	04-12-2024 08:00	21-11-2024 00:00	06-11-2024 09:23
- HEMATOLOGIE							
+ Hemoglobine	g/dL	Zie dagrapport	11.4	12.1	10.0	10.2	7.6
+ Hematocriet		Zie dagrapport	0.349	0.367	0.322	0.331	0.244
RBC telling	10**12/L	4.50 - 6.00	3.83		3.46		2.84
+ MCV	fL	Zie dagrapport	91.1	90.4	93.1	90.2	85.9
+ MCH	pg	Zie dagrapport	29.8	29.8	28.9	27.8	26.8
+ MCHC	g/dL	Zie dagrapport	32.7	33.0	31.1	30.8	31.1
RDW	%	11.7 - 14.5	17.5		22.0		15.9
+ Reticulocyten	10**3/ μ L	Zie dagrapport		23.1	34.9		31.5
Immat. Retic	%	5.0 - 21.0			8.6		11.5
Erytroblasten	/ 100 WBC	0.00 - 0.70	0.00		0.00		0.00
+ WBC telling	10**9/L	Zie dagrapport	3.98	5.21	2.79	3.94	3.13
+ Bloedplaatjes	10**9/L	Zie dagrapport	143	129	95	174	205

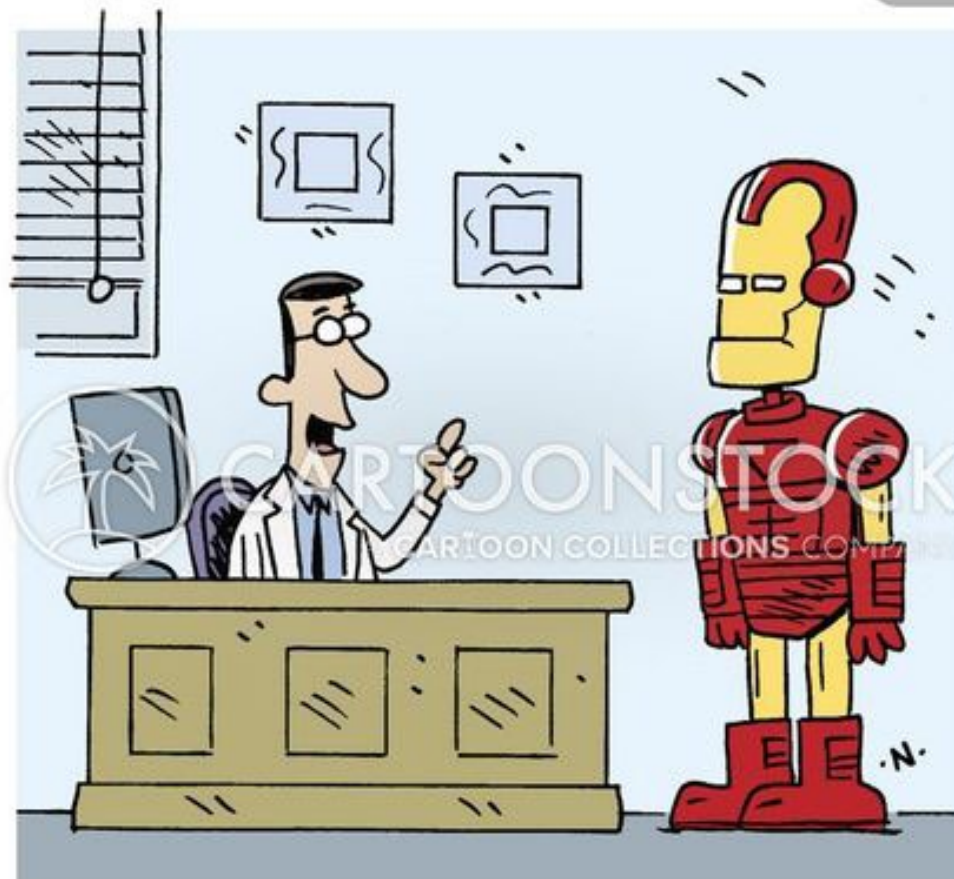
Diagnosis

- Longstanding pre-existing anemia
 - Renal anemia
 - Anemia of chronic disease
 - Decreased bone marrow reserve or MDS due to previous R/ ?
- Anemia after arterial stenting reveals iron-deficiency and iron-deficiency anemia
- IV iron corrects Hb level to higher levels than before



Missed component of iron deficiency contributing to chronic anemia!

CS635448



"Believe it or not, Mr. Stark...you have an iron deficiency."