

A microscopic view of blood cells, including red blood cells (erythrocytes) and white blood cells (leukocytes), set against a dark blue background. The red blood cells are prominent, appearing as bright red, biconcave discs. The white blood cells are larger and more varied in shape and color, including some with visible nuclei. The overall scene is illuminated from the left, creating a sense of depth and highlighting the textures of the cells.

Polycythemia

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Practical Hematology

1. Blood Loss Anemia
2. Hemolysis
3. Non-Regenerative Anemias
4. Bone Marrow Disease
5. Transfusion Medicine
6. Cases
7. **Polycythemia**
8. Coagulopathy
9. Central IV Lines
10. Leukophilia
11. Leukopenias
12. Splenic Disease



Polycythemia

Polys – many **Cytos** – cell **Haima** - blood
Aka – erythrocytosis

RBC **>10** x 10⁶/ul in the **dog**

RBC **>8.5** x 10⁶/ul in the **cat**

PCV **>55-60%** in the **dog**

PCV **>45-50%** in the **cat**

Relative polycythemia – decrease in plasma volume (hypovolemia), resulting in falsely increased PCV/HCT
plasma protein often elevated

- **Fluid loss**
- **Lack of access to or intake of water**
- **Splenic contraction (temporary, due to stress – dogs only)**

A vertical strip on the left side of the slide shows a microscopic view of red blood cells. The cells are depicted as red, biconcave discs of various sizes and orientations, set against a background of green and yellowish light, suggesting a fluid environment.

Absolute Polycythemia

Primary Polycythemia (PP) – Myeloproliferative disorder resulting in too many RBC in circulation

Secondary Appropriate Polycythemia (SAP) – increased RBC in response to chronic hypoxia

- High altitude
- Right to Left heart shunt
- Lung Disease (poor ventilation)
- VP mismatch – pulmonary hypertension

Secondary Inappropriate Polycythemia (SIP) – increased RBC due to increased EPO without systemic hypoxia

- Paraneoplastic
- Renal disease resulting in renal hypoxia (neoplasia, infection, inflammation, infarct, hydronephrosis, etc.)

A vertical strip on the left side of the slide shows a microscopic view of several red blood cells. The cells are depicted as biconcave discs, with some in sharp focus and others blurred in the background. The background has a greenish-yellow hue, suggesting a fluid environment.

Polycythemia

Clinical Signs:

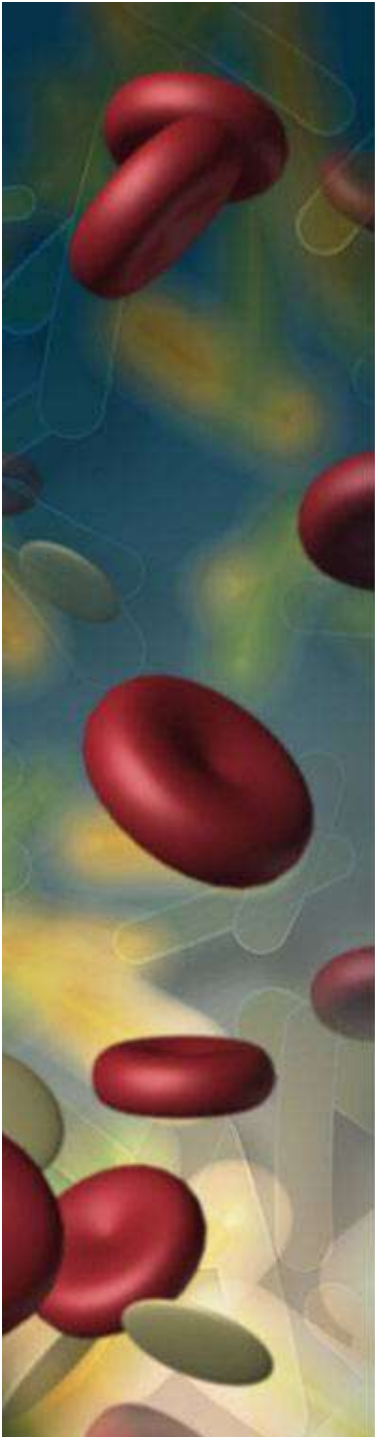
- exacerbated by exercise
- Brain hypoxia – seizures, blindness, behavior changes
- Peripheral hypoxia (positive feedback loop)
 - Lethargy, weakness, ataxia, tremors

Sequellae: hyperviscosity (doubled at 70%)

- Poor microcirculation
- Local hypoxia
- thrombosis

Pathophysiology

- **Kidney detects hypoxia**
- Releases HIF-1 (hypoxia-inducible factor 1)
- HIF-1 induces **EPO** gene transcription in the JG apparatus
- EPO plasma level increases
- EPO stimulates **RBC production in the bone marrow:**
 - Stimulates RBC mitosis
 - Enhances RBC differentiation
 - Prevents apoptosis of RBC precursors
- More RBC increase oxygen carrying capacity
- **Kidneys no longer hypoxic**



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Sighthounds

Higher reference values – increased red cell mass

- HCT, Hb, RBC
- Also increased MCV (macrocytosis)

RBC life span half of other dogs

- Normally 100-120 days
- Sighthounds 50-60 days

Predisposed to Babesia infection

A vertical strip on the left side of the slide shows a microscopic view of red blood cells. The cells are depicted as red, biconcave discs of various sizes and orientations, set against a background of green and yellowish-green, suggesting a fluid environment. The lighting creates highlights and shadows on the cells, giving them a three-dimensional appearance.

Primary Polycythemia

aka – polycythemia vera

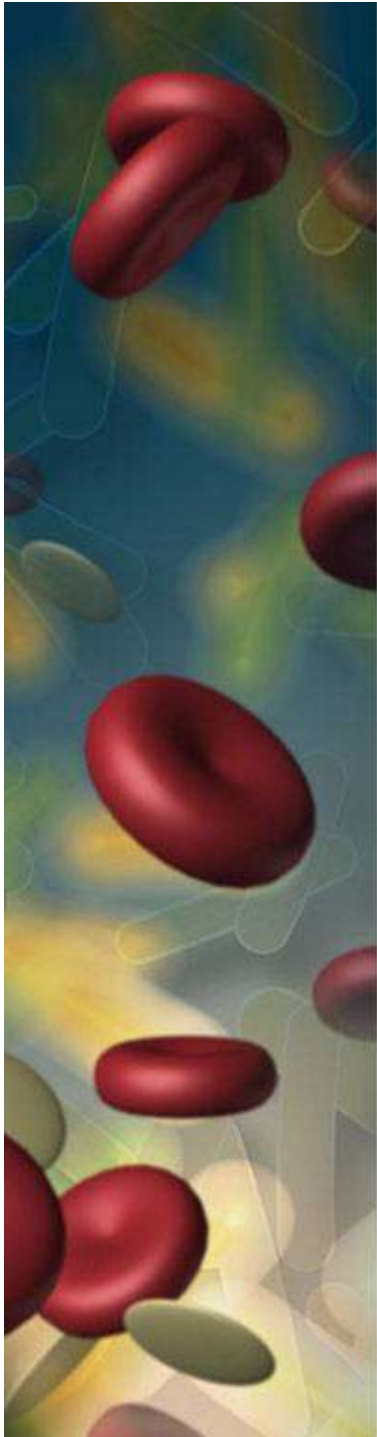
aka – chronic red cell leukemia

aka – primary erythrocytosis

Dx - a diagnosis of exclusion

- Bone marrow sampling not helpful to diagnosis, as erythroid hyperplasia is present with all absolute polycythemias
- EPO levels normal
- PCV often 70-80% despite fluid therapy

Bobby Cox Leonard TX





Secondary Appropriate Polycythemia

Clinical Signs:

- Dyspnea or cyanosis
- *Differential cyanosis:* restricted to rear of the body due to reverse PDA (rPDA)

Arterial blood gases: very low pO_2 , \pm high pCO_2

- Easier to get reliable results after phlebotomy

Pulse oximetry

- <80% oxygen saturation
- In rPDA, will be much lower on the rear of the dog or cat

CBC, profile, UA, chest rads, Abd US may show evidence of primary lung or heart disease

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Secondary Inappropriate Polycythemia

Clinical Signs: same as primary polycythemia, due to hyperviscosity

Arterial blood gases: normal

Pulse oximetry: normal

CBC, profile, UA, chest rads, Abd US may show evidence of primary neoplasia or kidney disease

Most common offending tumors & diseases:

- Any severe renal disease
- Renal neoplasia
- Leiomyoma/leiomyosarcoma
- Endocrine tumors – benign or malignant
- Liver tumors – benign or malignant

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EPO Levels

In theory: should be high with SAP and normal with PP and SIP

However: only 50% of dogs with SAP have high EPO levels

- If you get high EPO level, you have your diagnosis of SAP
- Normal EPO level is not helpful

Renal disease can result in anemia *or* polycythemia

A vertical strip on the left side of the slide shows a microscopic view of several red blood cells. The cells are depicted as biconcave discs, with a reddish-brown color and a darker center. They are set against a background of green and yellow, suggesting a fluid environment. The cells are arranged in a somewhat vertical column, with some overlapping.

Treatment

Relative Polycythemia: give IV fluids and treat primary problem

PP, SAP, SIP: serial phlebotomy. Leeching (4) for 48 hours has been used in fractious cats.

- Remove 10 ml/lb in dogs and 7 ml/lb in cats
- Replace with IV fluids
- Target: PCV <55% in dogs, <50% in cats

SAP (hypoxia): find the sweet spot between hypoxia and hyperviscosity

- Alternative to phlebotomy - hydroxyurea 30-50 mg/kg x 7d, then reduce to 15 mg/kg/day OR 50 mg/kg QOD, titrate both to effect

SIP: treat neoplasia or renal disease, if possible

- Phlebotomy to palliate symptoms of polycythemia



Prognosis

Relative Polycythemia: depends on primary problem

PP: 2-4 years with serial phlebotomy.

SAP (hypoxia):

- rPDA – 2-4 years with serial phlebotomy.
- Others – depends on primary problem

SIP: depends on neoplasia or renal disease.

- Benign neoplasms are potentially curable if surgically resectable.

[Polycythemia Diagnostic Handout 1](#)

[Polycythemia Diagnostic Handout 2](#)



Acknowledgements

Chapter 3: Erythrocytes Disorders

- Douglass Weiss and Harold Tvedten
- Small Animal Clinical Diagnosis by Laboratory Methods, eds Michael D Willard and Harold Tvedten, 5th Ed 2012

Chapter 60: Polycythemia

- Andreas Hans Hasler
- Textbook of Veterinary Internal Medicine, eds Stephen J Ettinger and Edward C Feldman, 6th Ed 2003