

Anesthesia Considerations for Anemia in Pregnancy

Bhavna Gupta¹, Lalit Gupta²

¹Senior Resident, Department of Anesthesia and ICU, MAMC AND LNH

²Assistant Professor, Department of Anesthesia and ICU, MAMC AND LNH

Email address: bhavna.kakkar@gmail.com

Abstract— The following article in brief describes the definition, pathophysiology, management and anesthesia management in a case of anemia in pregnancy. The review article in brief also describes the physiological changes of pregnancy.

Keywords— Pregnancy, Anemia, Anesthesia concerns.

I. INTRODUCTION

Anemia is defined as quantitative or qualitative reduction of hemoglobin or circulating red blood cells or both below a threshold lying at two SD below the median for a healthy population of the same age & sex. WHO defines anemia in pregnancy as Hemoglobin concentration <11gm% or hematocrit 33% in 1st & 3rd trimesters, <10.5gm% or < 32% in 2nd trimester. Indian Guidelines: ICMR Anemia Severity Classification is summarized in table I.

TABLE I. ICMR categories of Anemia of pregnancy.

Category	Severity	Hb level (gm %)
1	Mild	10 -10.9
2	moderate	7-10
3	Severe	<7
4	Very severe	<4

Classification of Anemia

- Physiological
- Pathological or acquired
- Morphological

Physiological Changes of Pregnancy

- Blood & its constituents** – Increase in plasma volume (50%) and red blood cell volume (40%), leading to state of haemodilution
- Cardiovascular system** – increase in cardiac output (50%), systolic blood pressure, and reduction in systemic vascular resistance thereby improving blood flow to organs
- Aortocaval compression** –Left lateral position should be kept to avoid aortocaval compression
- Respiratory system** – there is increase in tidal volume, minute ventilation and decrease in functional residual capacity, anemic pregnant females are more prone for hypoxemia. Also there is increased congestion of upper airway mucosa, therefore anesthesiologists should be careful during laryngoscopy and intubation and preferably one size smaller endotracheal tube should be preferred.
- Gastro-intestinal system** – aspiration prophylaxis should be given to pregnant females owing to increased chances of aspiration as there is reduction in gastric motility, increase in intra-gastric pressure and decrease in lower esophageal tone.

F. Coagulation system – there is increase in fibrinogen, VII, VIII, IX, X, XII levels, and decrease in XI level and overall increase in hyper coagulable state.

Pathological Anemia

- Nutritional - iron deficiency, macrocytic & dimorphic anemia (most common type)
- Hemorrhagic - acute (APH) & chronic (hookworms)
- Infections - malaria, HIV
- Hemoglobinopathies - sickle cell disease, thalassemia

Morphological Anemia

- **Microcytic hypochromic:** as in Fe deficiency, sideroblastic, thalassaemia where MCV, MCH, MCHC all reduced
- **Normocytic normochromic:** as in acute blood loss, haemolytic anemia, bone marrow failure, MCV, MCH, MCHC all normal
- **Macrocytic:** as in vitamin B₁₂, folic acid deficiency, MCV above normal (>90 fl)

Nutritional Anemia

- Iron Deficiency** - There is increase in iron requirement owing to increase in red cell mass, growing foetus, placenta, and cord. Overall a normal iron store in an adult female is 500 mg and total demand is 800-1400 mg (4mg/day) during pregnancy. There is reduction in total iron stores and serum ferritin during third trimester. Diagnosis is usually made by microcytic hypochromic RBCs and serum ferritin levels below 12 µ mol / L.
- Folate Deficiency** – folate requirement is doubled during last trimester, and body stores of folate are limited. It may be concomitantly present with iron deficiency anemia and patients usually have nonspecific symptoms. Diagnosis is made by presence of hyper segmented neutrophils, leucopenia, and thrombocytopenia and megaloblastic anemia. It is given prophylactically as 200-500 µg / d.
- Vitamin B₁₂ Deficiency**- is rare to find in clinical scenario and normal levels 205 – 1025 µg /L, during pregnancy because of increased requirement normal levels are 20 – 510 µg/L. requirement of vitamin B12 is 3 µg/ d during pregnancy.
- Aplastic Anaemia**

Compensatory Mechanism for Acute Anemia

- Increased velocity of blood flow

- Sympathetic stimulation - vasoconstriction, tachycardia, increase in stroke volume → increase in venous return → increased cardiac output
- Redistribution of blood flow to vital organs
- Water & electrolyte conservation (vasopressin, renin angiotensin)
- Constriction of capillary beds in skin, splanchnic
- Increased osmotic pressure → fluid shifts
- Anaerobic metabolism → acidemia → increase in ventilation

Management

1. **Iron Deficiency**- Oral iron therapy in dosage of 60 – 80 mg/day is recommended from second trimester. WHO recommends daily iron intake of 30 – 60 mg /day if iron stores are normal and 120 – 240 mg /day in case of depleted iron stores.

Side effects are usually epigastric discomfort, metallic taste and constipation.

Parenteral iron therapy is recommended in patients who are not compliant with oral iron medications and have intolerable side effects to oral therapy or in those patients who are diagnosed late during pregnancy. The various formulations of parenteral iron therapy as ae follows:

1. **IRON SORBITOL CITRATE**- it is given as intramuscular injection, and may lead to headache, and anaphylactoid reactions.
2. **IRON DEXTRAN** - it is given as either intramuscular injection
DOSE = (250 X Deficiency of Hb in gm %) + 500mg (STORE)
3. **IRON SUCROSE** - is given as intravenous injection, and is known to have a slow release with low allergenic properties.

There is increase in Hb concentration by 0.8 gm % per week.

2. Indications of Transfusion

Pregnancy less than 36 wks

- Hb ≤ 5gm/dl without clinical signs of CHF
- Hb 5-7gm/dl with CHF, hypoxia, infections, septicemia, heart disease not due to anemia

Pregnancy 36 wks or more

- Hb ≤ 6gm/dl
- Hb 6-8gm/dl with CHF, hypoxia, infections, heart disease not due to anemia, septicemia

Elective LSCS

- H/o APH, PPH, previous LSCS

$$\text{VOL} = \frac{\text{NORMAL BLOOD VOLUME X Hb \% RISE NEEDED}}{\text{Hb \% OF TRANSFUSED BLOOD}}$$

Precautions to be taken during blood transfusion are that small volumes should be transfused at a time, with diuretics usage to avoid cardiac overload. Transfusion should preferably be given 48 hours before planned delivery.

The *major disadvantages* of Blood transfusion is that it can cause impairment of iron dependent enzymes, transfusion

reactions, cardiac overload, decrease in oxygen delivery owing to reduced 2-3 DPG levels in stored blood.

Anesthesia Management

It involves thorough pre-operative assessment, evaluation of cause, type and severity of anemia and adequacy of compensatory mechanism.

Pre-anesthetic (PAC) Checkup:

- a. History of tiredness, easy fatigability, breathlessness, dyspnea, palpitations, should be taken.
- b. H/o increased or acute blood loss from GIT, female genital tract
- c. H/o chronic disease which may be associated with anemia i.e CRF, connective tissue disorders, infections, malignancy, diabetes, AIDS, alcoholic liver disease and even pregnancy.
- d. H/o conditions which will worsen O₂ delivery to tissues i.e. COPD, restrictive lung disease.
- e. H/o conditions which will predispose patients to increased risk from anemia. Eg. IHD
- f. H/o conditions where cardiovascular reserve is inadequate to respond to decreased +O₂ supply. Eg. Congestive heart failure.
- g. H/o prior transfusion, drug/ alcohol intake should be sought.
- h. Nutritional habits and racial background should be known.
- i. Family h/o anemia should be taken.
- j. H/o Worm infestation should be sought.

Signs to be looked for:

- signs of high co like tachycardia, wide pulse pressure and systolic ejection murmur
- Koilonychia (spoon shaped brittle nails) angular stomatitis, glossitis → Iron deficiency anemia.
- Icterus, splenomegaly, bossing of forehead and enlargement of molar eminence (extramedullary haemopoiesis, failure to thrive. → thalassemia.
- Smooth tongue, hyperpigmentation, mental depression, peripheral edema → folic acid deficiency
- Symmetrical paresthesia with loss of proprioception and vibratory sensation in lower limbs, unsteady gait, memory impairment → Vit B₁₂ deficiency.

Pre-Operative Investigations

Complete Blood Count

- A. RBC count – Hemoglobin, Hematocrit
- B. RBC Indies – MCV (mean cell volume)
 - MCH (mean cell Hb)
 - MCHC (mean cell Hb concentration)
 - RDW (red cell distribution width)
- C. White blood cell count
 - a. Differential cell count
 - b. Nuclear segmentation of neutrophils
- D. Platelet count
- E. Cell Morphology (peripheral blood smear)
 - a. Cell size
 - b. Hemoglobin content
 - c. Anisocytosis

- d. Poikilocytosis
- e. Polychromasia

Other lab tests done in evaluation of anemia are :

- I. Reticulocyte count
- II. Iron supply studies
 - a. Serum Iron
 - b. Total iron binding capacity
 - c. Serum ferritin
 - d. Marrow iron stain
- III. Bone marrow examination
 - a. Aspirate
 - i. Erythroid/granulocyte precursor ratio
 - ii. Cell Morphology
 - iii. Iron stain
 - b. Biopsy
 - i. Cellularity
 - ii. Morphology
- IV. Other relevant investigations: ESR, blood urea, S. creatinine, bilirubin levels, Serum proteins, stool-occult blood, hook worm, TSH, ECG.

Considerations

- 1) Maintain cardiovascular stability – avoid myocardial depression, tachycardia (increasing myocardial oxygen demand), hypovolemia causing impaired tissue perfusion and hypervolemia increasing chances of cardiac overload,
- 2) Avoid aortocaval compression,
- 3) Avoid hypoxia,
- 4) Minimize factors causing left ward shift of ODC (hyperventilation, alkalosis, hypothermia, decrease in 2-3 DPG, etc)
- 5) Monitor complication –CHF, Shock.

Advantage of Regional Anesthesia

- 1) It is relatively safer in patients with moderate anemia with no cardiac decompensation, but should be avoided in patients with severe anemia with decompensation.
- 2) Regional has a psychological benefit for the mother as she is aware of her child birth.
- 3) Analgesia can be extended in the post-operative period, and risks involved with general anesthesia (chances of aspiration etc) are avoided.
- 4) Combined spinal epidural anesthesia has an added advantage of providing a dense blockade; titratability of drug with hemodynamics can be achieved with added advantage of post-operative provision of analgesia.
- 5) The major disadvantage of regional anesthesia is the sympathetic blockade extending above T4 which can lead to sudden hypotension and increasing further load on heart and impairment of respiration and oxygenation.
- 6) Special precautions must be taken to give supplemental oxygen to the patient, and to avoid fluid overload. Over sedation should be avoided. Mild anxiolytics can be desirable.

General Anesthesia

GA is the anesthesia of choice in severely anemic or moderate anemic patients with cardiac decompensation.

- 1) The major advantages of general anesthesia are rapid induction, better cardiovascular stability, control of airway and ventilation, less hemodynamic changes, allaying anxiety of a parturient female, thereby preventing cardiovascular changes associated.
- 2) Disadvantages of general anesthesia include chances of aspiration, hypoxemia during induction (therefore pre oxygenation for 5 minutes is preferred), failed intubation, awareness to the mother, neonatal effects if induction delivery time is more than 8 minutes and uterine incision-delivery time is more than 3 minutes.
- 3) Depending upon severity of anemia, patients may require post-operative ventilator support.

Special Concerns

A. Sickle Cell Anemia (SCA)

Sickle cell anemia is characterized by presence of HbS in which valine substituted for glutamic acid in 6th place on β chain, thereby leading to formation of insoluble globulin polymers when deoxygenated.

Clinical features are due to chronic hemolysis & occlusion of blood vessels with sickle cells and patients are susceptible to infarctive, aplastic & sequestration crisis. Pregnancy typically exacerbates complications.

Factors That Increase Sickling include hypoxia, in which $pO_2 < 50$ mmHg, HbS $> 50\%$ of the total, dehydration leading to increased blood viscosity, hypotension causing vascular stasis, hypothermia and acidosis

Interaction of SCA with Pregnancy

- Increased incidence of pneumonia & pyelonephritis
- Increased CO \rightarrow marked ventricular hypertrophy \rightarrow deterioration in diastolic function
- Decreased RBC life \rightarrow anemia, jaundice, cholecystitis, hyper dynamic circulation
- Vaso-occlusive events \rightarrow infarctive crisis, CVA, peripheral neuropathy
- Folate deficiency \rightarrow marrow failure \rightarrow depression of erythropoiesis \rightarrow aplastic crisis
- Increased incidence of preterm labour, placental abruption, placenta previa, PIH

Anesthesia Management in Sickle Cell Disease

- Pain control during labour essential
- Continuous lumbar epidural analgesia
- Operative delivery – GA or RA acceptable

Principles

- Use of crystalloids for intravascular volume
- Transfusion of RBC for O_2 carrying capacity
- Supplemental O_2 , pulse oximeter
- Normothermia
- Prevention of peripheral venous stasis
- Avoid – hypoxia, hypotension, acidosis, hypothermia and dehydration.

B. Pregnancy and Asthma

The following drugs should be avoided in pregnant patients with asthma:

- Prostaglandin F₂α and E₂
 - Ergometrine
 - Aspirin/other NSAIDs
 - Histamine-releasing drugs e.g. Atracurium, Rapacuronium
- 1) *During labour*: Adequate analgesia must be provided to avoid maternal stress, reduce oxygen consumption and hyperventilation and reduce chances of bronchospasm.
 - 2) *During LSCS*: Single shot spinal anesthesia may not be tolerated due to a faster onset of more dense motor block as compared to a slow control epidural injection in parturient with severe unstable asthma. Moreover a precise control of upper level of anesthesia can be predicted with a CSE or an epidural anesthesia.

- 3) *Unopposed H₂ receptor antagonists* can increase sensitivity to histamine induced bronchoconstriction hence non particulate antacids as sodium citrate are a better option in pregnant patients.
- 4) *Both theophylline and β₂ agonists* inhibit uterine activity when combined with volatile anesthetic agents and thus predispose to hemorrhage.

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