The Value of Routine Preoperative Hemoglobin Testing in Pediatrics Undergoing Surgery at Tertiary Care Setting in Egypt:Observational Cross Sectional Study

Thesis

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The Candidate

Rabab Mohamed Sabry

Abstract

IN This study that a policy of “routine” blood testing before surgery in Cairo University Paediatric Specialized Hospital for children is not recommended for patients undergoing minor surgeries. Intermediate surgical procedures and major surgeries detect a considerable proportion of anaemic paediatrics, we suggest routine blood testing before surgeries to protect against intaoperative and postoperative blood transfusion. designed to investigate whether a routine preoperative full blood count is of value or not in the context of high prevalence of anemia in Egypt.The study was conducted on two hundred patients with age ranged from 1 month to 12 years in Cairo University specialized pediatric hospital, which revealed that there was no significant differences between anaemia and different age groups, gender and type of surgery.

Keywords

FBC- Hemoglobin- DPG-SBSS

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LIST OF ABBREVIATIONS

AAP	: American Academy of Pediatrics.
ASA	: American Society of Anesthesiologists.
DPG	: Diphosphoglycerate.
FBC	: Full blood count.
FiO2	: Inspired fraction of oxygen.
Hb	: Hemoglobin.
NICE	: National Institute for Health and Care Excellence.
RBC	: Red blood cell.
SPSS	: Statistical Package for Social Sciences.
WHO	: World Health Organization.

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Introduction

Anemia is strictly defined as a decrease in red blood cell (RBC) mass. The function of the RBC is to deliver oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. This is accomplished by using hemoglobin (Hb), a tetramer protein composed of heme and globin. Anemia impairs the body's ability for gas exchange by decreasing the number of RBCs transporting oxygen and carbon dioxide [(1)].

Pediatric anemia refers to a hemoglobin or hematocrit level lower than the age-adjusted reference range for healthy children. Physiologically, anemia is a condition in which reduced hematocrit or hemoglobin levels lead to diminished oxygen-carrying capacity that does not optimally meet the metabolic demands of the body[(2)].

International guidelines recommend against routine preoperative testing of full blood count (FBC) in pediatrics before elective surgery. According to the NICE clinical guideline on preoperative laboratory testing in children less than 16 years, FBC is not recommended before grade 1 (minor) and grade 2 (intermediate) surgeries, and to be considered in grade 3 (major), grade 4(major+), and neurosurgeries and mandatory only in cardiac surgery.

Roy WL et al,. (1991) [(3)] investigated the value of routine preoperative hemoglobin testing in pediatric patients scheduled for minor surgery. They found that healthy pediatric patients five years and older scheduled for minor surgery don't require routine hemoglobin determination. More recently, De **Sousa Soares et al,. (2013)** [(4)] investigated the relevance of routine testing in low risk patients undergoing minor and medium surgical procedures.

They concluded that preoperative additional tests are excessively ordered, even for young patients with low surgical risk, with little or no interference in perioperative management. They stated that laboratory tests, besides generating high and unnecessary costs, are not good standardized screening instruments for diseases.

Although it was concluded in previous studies[3,4] that preoperative laboratory test is not recommended routinely as it is not agood standardized screening instrument for disease this is not the case in Egypt . In a study done by **Curtale et al ,.(1998)** [5] studied anemia and intestinal parasitic infections among school age children in Behera governorate in Egypt, and found that the prevalence of anemia in the area was high (90%).

Also in another study done 2001 in Deshna and Armant Districts of Qena Governorate, Upper Egypt, to establish the prevalence of anemia among schoolchildren aged 6 to 11 years and define appropriate control interventions in the area. The mean (SD) level of hemoglobin in 1844 schoolchildren in 37 schools was 12.79 (1.15) g/dL. Only 12% of children were below the WHO cut-off for anemia for this age group (< 11.5 g/dL) and no cases of severe anemia (< 7.0 g/dL) were detected [6].

In our Cairo University specialized pediatric hospital, the practice is to do routine preoperative full blood count to all children. In the current observational study aimed to whether a routine preoperative full blood count is of value or not in the context of high prevalence of anemia in Egypt.

Hemoglobin

Haemoglobin (Hb) is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates (with the exception of the fish family Channichthyidae) as well as the tissues of some invertebrates. Haemoglobin in the blood carries oxygen from the lungs) to the rest of the body (i.e. the tissues) where it releases the oxygen to burn nutrients to provide energy to power the functions of the organism in the process called metabolism.

Haemoglobin has an oxygen-binding capacity of 1.34 mL O2 per gram of haemoglobin, which increases the total blood oxygen capacity seventy-fold compared to dissolved oxygen in blood. The mammalian haemoglobin molecule can bind (carry) up to four oxygen molecules [(7)].

Haemoglobin is involved in the transport of other gases: It carries some of the body's respiratory carbon dioxide (about 10% of the total) as carbaminohemoglobin, in which CO2 is bound to the globin protein. The molecule also carries the important regulatory molecule nitric oxide bound to a globin protein thiol group, releasing it at the same time as oxygen [(8)].

Haemoglobin is also found outside red blood cells and their progenitor lines. Other cells that contain hemoglobin include the A9 dopaminergic neurons in the substantia nigra, macrophages, alveolar cells, and mesangial cells in the kidney. In these tissues, haemoglobin has a non-oxygen-carrying function as an antioxidant and a regulator of iron metabolism [(9)]

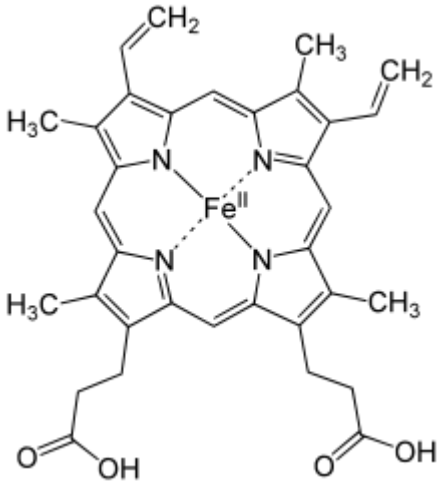

Fig.1: *Haeme b group* (10)

Haemoglobin has a quaternary structure characteristic of many multi-subunit globular proteins. Most of the amino acids in hemoglobin form alpha helices, connected by short non-helical segments. Hydrogen bonds stabilize the helical sections inside this protein, causing attractions within the molecule, folding each polypeptide chain into a specific shape. Haemogoblin's quaternary structure comes from its four subunits in roughly a tetrahedral arrangement (10).

In most vertebrates, the haemoglobin molecule is an assembly of four globular protein subunits. Each subunit is composed of a protein chain tightly associated with a non-protein haeme group. Each protein chain arranges into a set of alpha-helix structural segments connected together in a globin fold arrangement, so called because this arrangement is the same folding motif used in other haeme/globin proteins such as myoglobin. This folding pattern contains a pocket that strongly binds the haeme group(11).

A haeme group consists of an iron (Fe) ion (charged atom) held in a heterocyclic ring, known as a porphyrin (fig 1). This porphyrin ring consists of four pyrrole molecules cyclically linked together (by methine bridges) with the iron ion bound in the center. The iron ion, which is the site of oxygen binding, coordinates with the four nitrogens in the center of the ring, which all lie in one plane (fig 2). The iron is bound strongly (covalently) to the globular protein via the imidazole ring of F8 histidine residue (also known as the proximal histidine) below the porphyrin ring. A sixth position can reversibly bind oxygen by a coordinate covalent bond, completing the octahedral group of six ligands. Oxygen binds in an "end-on bent" geometry where one oxygen atom binds Fe and the other protrudes at an angle.

When oxygen is not bound, a very weakly bonded water molecule fills the site, forming a distorted octahedron [12].

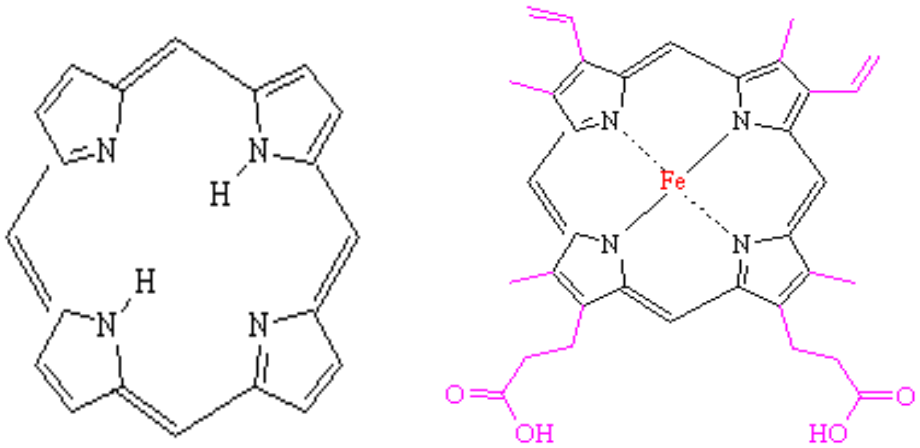

Fig .2 Porphyrin ring haeme group [12]

Even though carbon dioxide is carried by haemoglobin, it does not compete with oxygen for the iron-binding positions but is bound to the protein chains of the structure.

The iron ion may be either in the ferrous (Fe^{2+}) or in the ferric (Fe^{3+}) state, but ferrihaemoglobin (methaemoglobin) (Fe^{3+}) cannot bind oxygen [13].

In adult humans, the most common hemoglobin type is a tetramer (which contains 4 subunit proteins) called *haemoglobin A*, consisting of two α and two β subunits non-covalently bound, each made of 141 and 146 amino acid residues, respectively. This is denoted as $\alpha_2\beta_2$. The subunits are structurally similar and about the same size. Each subunit has a molecular weight of about 16,000 daltons, for a total molecular weight of the tetramer of about 64,000daltons (64,458g/mol).

In human infants, the haemoglobin molecule is made up of 2 α chains and 2 γ chains.

The gamma chains are gradually replaced by β chains as the infant grows. The four polypeptide chains are bound to each other by salt bridges, hydrogen bonds, and the hydrophobic effect [14].

Synthesis

Haemoglobin is synthesized in a complex series of steps. The heme part is synthesized in a series of steps in the mitochondria and the cytosol of immature red blood cells, while the globin protein parts are synthesized by ribosomes in the cytosol.(fig 3)

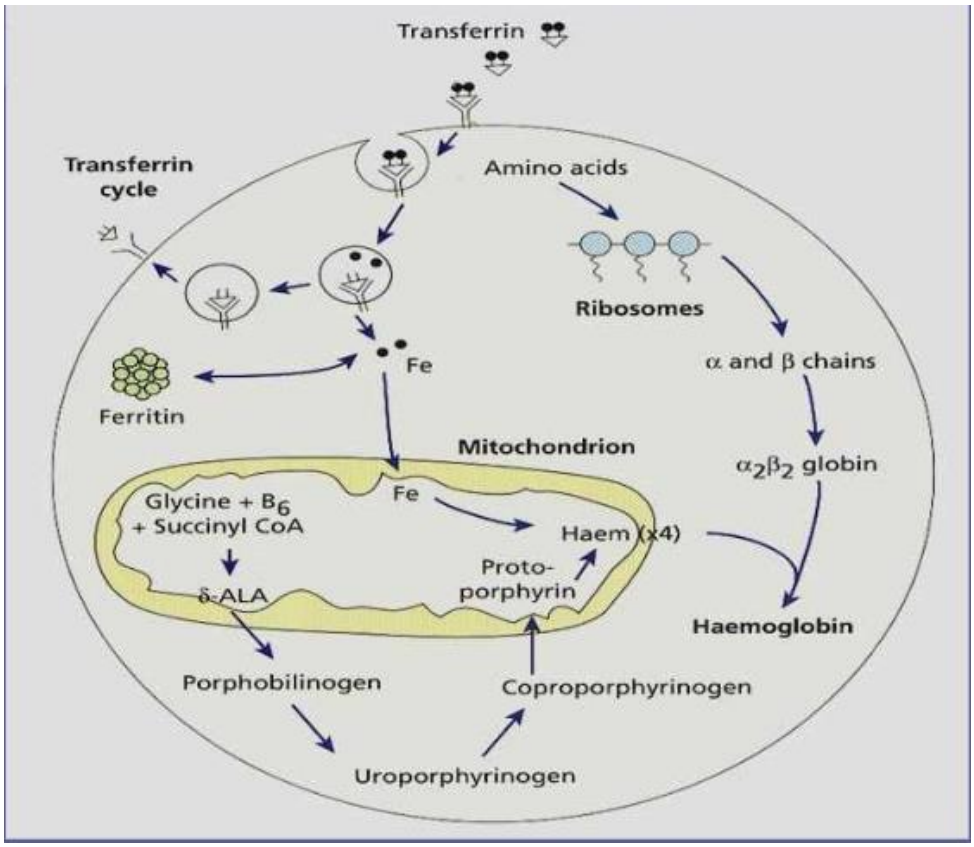

Fig . 3 Synthesis of Haemoglobin.[15]

Production of Hb continues in the cell throughout its early development from the proerythroblast to the reticulocyte in the bone marrow. At this point, the nucleus is lost in mammalian red blood cells. Even after the loss of the nucleus in mammals, residual ribosomal RNA allows further synthesis of Hb until the reticulocyte loses its RNA soon

after entering the vasculature (this hemoglobin-synthetic RNA in fact gives the reticulocyte its reticulated appearance and name) .[15]

Oxygen saturation

In general, hemoglobin can be saturated with oxygen molecules (oxyhaemoglobin), or desaturated with oxygen molecules (deoxyhaemoglobin) [16]

Oxyhemoglobin

Oxyhaemoglobin is formed during physiological respiration when oxygen binds to the heme component of the protein hemoglobin in red blood cells. This process occurs in the pulmonary capillaries adjacent to the alveoli of the lungs. The oxygen then travels through the blood stream to be dropped off at cells where it is utilized as a terminal electron acceptor in the production of ATP by the process of oxidative phosphorylation. It does not, however, help to counteract a decrease in blood pH. Ventilation, or breathing, may reverse this condition by removal of carbon dioxide, thus causing a shift up in pH. [17]

Hemoglobin exists in two forms, a *taut (tense) form* (T) and a *relaxed form* (R). Various factors such as low pH, high CO_2 and high 2, 3 DPG at the level of the tissues favor the taut form, which has low oxygen affinity and releases oxygen in the tissues. Conversely, a high pH, low CO_2, or low 2, 3 DPG favors the relaxed form, which can better bind oxygen. [17]