



BLOOD VOLUME

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ABSTRACT:

The presence of total amount of blood in the circulatory system, blood reservoirs, organs and tissues together form blood volume. The blood volume is about 5 L in normal young healthy adult male. It is equal to 7% of total body weight. It maintains the range between 6% and 8% of body weight. Generally the blood volume is 2.8 to 3.1 L/sq Meter regarding surface area.

KEY WORDS: *circulatory system, blood reservoirs, organs.*

Discrepancies in Blood Volume

➤ Physiological discrepancies:

a) Age:

Especially at birth absolute blood volume is less. It enhance gradually as age increases. Whatever it may be, at the birth blood is less compared to body surface area and more when compare to body weight.

b) Sex:

Normally in males, the blood volume is slightly higher than females due to enhancement of erythropoietin activity, surface area of the body and body weight. Generally in females, blood volume is slightly less due to loss of blood through menstruation, less body surface area as well as more fats.

c) Body weight:

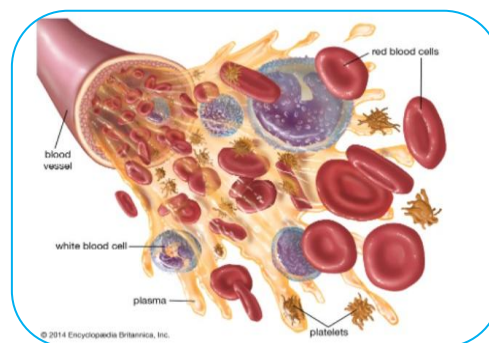
The blood volume is directly proportional to body weight.

d) Surface area of the body:

Blood volume is directly linked to surface area of the body.

e) Atmospheric temperature:

The blood volume is decreased due to exposure to cold environment and the blood volume is enhanced due to exposure to hot climate.



f) Emotion:

Excitement enhances the blood volume due to sympathetic activation which induces splenic contraction release of stored blood into blood vessels that is circulation.

g) High altitude:

An enchantment of blood volume takes place in high altitude. It is due to hypoxia which activates the secretion of erythropoietin. Erythropoietin leads to the enhancement in the production of many RBC's. Many RBC's lead to enhancement in blood volume.

h) Exercise:

Exercise enhances the blood volume by stimulating the erythropoietin and production of many RBC's.

i) Pregnancy:

Normally during initial stages of pregnancy, blood volume enhances by 20-30 % because of the enhanced fetal mass as well as retention of sodium. Whatever it may be, blood volume is decreased during later stages of pregnancy. **J) Posture:**

Normally standing for longtime decrease blood volume approximately 15%. It happens due to pooling of blood in lower limbs. During standing, blood volume enhances the hydrostatic pressure. The pressure assists in pushing fluid from blood vessels into the tissue spaces. Now the blood volume is reduced.

> Pathological discrepancies:

Abnormal increase in blood volume is called hypervolemia and abnormal decrease in blood volume is called hypovolemia.

Hypervolemia:

More blood volume is known as hypervolemia. This is frequently associated in various conditions including congestive heart failure, liver cirrhosis, hyper aldosteronism and hyper thyroidism.

Hypovolemia:

Low blood volume is known as hypovolemia. It is seen in very few conditions namely anemia, dehydration, hemolysis, hemorrhage or blood loss and hypothyroidism.

Measurement of blood volume:

Measurement of blood volume takes place by two methods such as direct method as well as indirect method.

Direct Method:

This method is observed only in situations involving animal because it includes sacrificing the life of an animal. The killing of animal happens with decapitation and blood is collected. The washing of the blood vessels and tissues is done effectively with known quantity of either saline or water. And, this is clubbed to the blood collected already. Now the measurement of total volume to be considered. From this, the volume of saline or water utilized for washing the tissues is excluded to know the volume of the blood in the animal. This method was discovered by **WELCKER**. Afterwards **B'SCHOFF** utilized the method on decapitated criminals to estimate blood volume in humans.

Indirect Method:

Indirect method has gained popularity because, it is used to measure the blood volume in human beings without creating any discomfort or any type of difficulty to the subject.

Measurement of total blood is in two steps such as

- a) Determination of plasma volume.
- b) Determination of blood cell volume.

1. Estimation of plasma volume:

Determination of plasma volume takes place by two methods such as i) Dye or indicator technique

ii) Radio isotope method.

I) Estimation of plasma volume by dye dilution or indicator technique:

Principle:

Generally a known quantity of compound such as dye is injected into specific body fluid compartment. These compounds are termed as marker substance or indicators. After entry into the fluid, the compound is allowed to mix thoroughly with the fluid compartment. Then a sample of fluid is collected and the concentration of the marker compound is determined. Radio active compounds or other compounds whose concentration can be estimated by using colorimeter are normally used as marker compounds. Formula to estimate the volume of blood or fluid is;

$$V=M/C$$

V= the volume of fluid in the compartment.

M= mass or total quantity of marker compound injected.

C= concentration of an indicator/ marker compound in the sample fluid.

Correction factor:

Some quantity of marker compound is excreted through urine during distribution. So, the formula is corrected as follows:

$$\text{Volume} = \frac{\text{M} - \text{Amount of substance excreted}}{C}$$

Uses of indicator dilution method:

This method is useful to measure plasma volume.

Characteristics of Marker substance:-

Dye or any substance used as a marker had to have the following qualities:

1. Must be nontoxic
2. Must mix with the fluid compartment thoroughly within reasonable time.
3. Should not be excreted rapidly.
4. Should be excreted from the body completely within reasonable time.
5. Do not change the color of body fluids.
6. Do not alter the volume of the body fluid.

MEASUREMENT OF PLASMA VOLUME:

The compounds which binds with plasma proteins effectively and diffuses into interstitium only in small quantities or those that do not diffuse is used to measure plasma volume. Such compounds are radio active Iodine (¹³¹I) and Evans blue (T-1824).

Procedure:

10 ml of blood is collected from subject. This is made into 2 equal portions. One part, known amount of dye is added. This is treated as controlled sample in the procedure. The other portion is utilized to estimate hematocrit value. Then known volume of dye is injected intravenously. After 10 mins a sample of blood is collected. Then, another 4 samples of blood are obtained at an interval of 10 mins. All these 5 blood samples are spun to separate the plasma. In plasma isolated from each sample, dye concentration is measured by colorimetry and using these results, average dye concentration has to be evaluated.

The subject urine is collected and the amount of dye appeared or excreted in the urine is measured.

Calculation:

The plasma volume is calculated by using the formula..

$VOLUME = \text{amount of dye injected} - \text{amount excreted} / \text{average concentration of dye in plasma.}$

ii) Estimation of plasma volume by radio isotope method:

Radioactive iodine (^{131}I or ^{132}I) is injected into body. After few minutes or hours, a sample of blood is obtained. The radioactivity is estimated with the help of appropriate counter. From this, the plasma volume is estimated.

Estimation of blood cell volume:**Blood cell volume is determined by two methods:**

- i. By measuring hematocrit value
- ii. By radioisotope dilution method

i) Determination of blood cell volume by hematocrit value

This is usually done by centrifuging the blood and measuring the packed cell volume as a percentage of total blood volume (PCV). If the PCV is deducted from 100, the percentage of plasma is known. From this and from the volume of plasma, the amount of total blood is calculated by using the formula.

$\text{Blood volume} = 100 \times \text{Amount of plasma} / 100 - \text{PCV}$

ii) Determination of blood cell volume by radioisotope method

The volume of blood cell is measured by radioisotope method also. Radioactive chromium (Cr^{52}) is mixed with heparinized blood and incubated for 2 hours at 37°C , which results in tagging all the red blood cells with Cr^{52} that are injected intravenously. After providing sufficient time for mixing, a sample of blood is collected. The hematocrit value is estimated by measuring the radioactivity in the blood sample. Radioactive iron (Fe^{59} , Fe^{55}) or phosphorus (P^{32}) is also used for estimation of hematocrit value.



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