

Hypovolemia

Blood and Plasma Expander

Hypovolemia

An abnormal decrease in blood volume
or,
an abnormal decrease in the volume of
blood plasma

Hypo" means *low*, "vol" is for *volume*,
and "emia" refers to *blood*..

Hypovolemic shock

Hypovolemic shock refers to a medical or surgical condition in which rapid fluid loss results in multiple organ failure due to inadequate circulating volume and subsequent inadequate perfusion

Most often, hypovolemic shock is secondary to rapid blood loss
(Hemorrhagic shock).

The 4 classes of shock:

- Hypovolemic
- Vasogenic (septic)
- Cardiogenic
- Neurogenic

Hemorrhagic shock

Prognosis

- Amount of blood volume lost
- Rate of blood loss
- Age
- preexisting medical conditions
- Illness or injury causing the loss

Classes of Hemorrhage

- ❑ **Class I Hemorrhage** involves up to 15% of blood volume ,
- ❑ **Class II Hemorrhage** involves 15-30% of total blood volume
- ❑ **Class III Hemorrhage** involves loss of 30-40% of circulating blood volume.
- ❑ **Class IV Hemorrhage** involves loss of >40% of circulating blood volume

American College of Surgeons'

Pathophysiology

Activation of the following major physiologic systems :

- hematologic,
 - cardiovascular,
 - renal, and
 - neuroendocrine systems.
- coagulation cascade , contracting the bleeding vessels
 - the heart rate , myocardial contractility , peripheral blood vessels.
 - increased release of norepinephrine and decreased baseline vagal tone
 - Corticotropin-releasing hormone , to glucocorticoid and beta-endorphin release , Vasopressin , Renin ,
Hyperglycemia commonly is associated with acute hemorrhage.

Diagnosis

* **External blood loss**

* **Internal bleeding**

No change in vital signs

Tachycardia, Skin may start to look pale and be cool, slight changes in behavior

Blood pressure drops, the heart rate increases, peripheral perfusion such as capillary refill worsens, and the mental status worsens

The limit of the body's compensation is reached and aggressive resuscitation is required to prevent death.

- Do not rely on systolic BP as the main indicator of shock**
- More attention should be paid to the pulse, respiratory rate, and skin perfusion**

MANAGEMENT OF BLOOD LOSS

- Blood Product Transfusion
- Replacement fluids:
 1. Crystalloids
 2. Colloids
 3. Hypertonic saline and Dextran

Blood Product Transfusion

- 1. Packed red blood cells:** A blood product that contains red blood cells with most of the plasma eluted off. The average hematocrit of PRBC's is 70%.
 - Each unit of PRBC's (220 ml) will raise the hematocrit by about 3%.

Blood Product Transfusion

٢. **Fresh frozen plasma:** A blood product that contains fresh components of plasma, including colloid proteins and clotting factors

The optimal ratio of FFP:PRBC during massive transfusion may be different to 1:1

٣. **Platelets:** A blood product that contains primarily platelets suspended in a small amount of plasma drawn from a single donor.

(six units platelets) will raise the count by approximately 60,000

Blood Product Transfusion

- ξ. **Cryoprecipitate:** A blood product component of plasma that primarily contains Factor VIII, Factor V and fibrinogen
 - This is the best blood product for treatment of low fibrinogen (<150 mg/dL)
 - a. Absolute indication: non-surgical bleeding with fibrinogen <100 mg/dL.
 - b. Relative indication: non-surgical bleeding after massive transfusion before a fibrinogen level can be obtained

Replacement fluids:

- Crystalloids
- Colloids
- Hypertonic saline and Dextran

Why use crystalloids?

The advantages of crystalloid solutions are:

- Inexpensive
- Easy to store with long shelf life
- Readily available
- Very low incidence of adverse reactions
- A variety of formulations are available
- Effective for use as replacement fluids or maintenance fluids
- No special compatibility testing is required.
- No religious objections to their use

Colloids

- Stay in the intravascular compartment for longer than crystalloids, and therefore less volume is needed
- increase colloidal osmotic (or oncotic) pressure
- It is useful in a patient with severe haemorrhage before blood is available and severe hypovolaemia after major trauma.
- Types: **natural colloids, dextrans, gelatines, and hydroxyethyl starches**

The Properties of an Ideal Colloid

- Distributed to intravascular compartment only
- Readily available
- Long shelf life
- Inexpensive
- No special storage or infusion requirements
- No special limitations on volume that can be infused
- No interference with blood grouping or cross-matching
- Acceptable to all patients & no religious objections to its use
- Half-life should be 6 to 12 hours
- Should be metabolised or excreted & not stored in the body
- Non-Toxic & No Adverse Affect on Body Systems**
- No interference with haemostasis or coagulation

Gelatine

- ❑ The gelatines commonly used are Haemaccel and Gelofusine
- ❑ Have a molecular weight of 35 kDa and 30 kDa respectively.
- ❑ They are isotonic, but because they are readily excreted by the kidney their half life in the circulation is **only two to three hours.**

Hydroxy -ethyl starch products

- ❑ They are more expensive than dextrans and gelatines but cheaper than blood products.
- ❑ They expand the intravascular compartment slightly in excess of the volume infused
- ❑ Have a half-life of about **six hours**.
- ❑ They may improve the haemodynamic status for **24 hours** or longer
- ❑ HES derivatives with a higher molecular weight (200 kDa) have been demonstrated to have increased rates of acute renal failure
- ❑ HES 130kDa (**Voluven**)

Hypertonic saline and Dextran

- theoretical benefit of increasing intravascular volume with only small amounts of fluid
- The combination of improve cardiac contractility and circulation
- be beneficial in situations where infusion of large volumes of fluid may be harmful, such as in the elderly with impaired cardiac activity.
- Additional trials will be required before this combination is accepted as standard of care.

Suitable Blood Replacement Regimes for Previously Healthy Adults

Estimated blood loss	Suitable fluid Regimes		
1000 mls	3000 mls crystalloid	or	1000 mls colloid
1500 mls	1500 mls crystalloid & 1000mls colloid	or	4500 mls crystalloid
2000 mls	1000 mls crystalloid, 1000mls colloid & 2 units blood	or	3000 mls crystalloid & 2 units blood

Guidelines on the Management of Massive Blood Loss

- British Committee for Standards in Hematology
- Date for guideline review July 2009

Massive blood loss:

- ❑ loss of one blood volume within a 24 h period
- ❑ Alternative definitions include 50% blood volume loss within 3 h or a rate of loss of 150 ml/min
- ❑ Massive" Transfusions = 1 Whole Blood Volume/24 hours or 50% in 3 hours.
- ❑ where 1 Whole Blood Volume = 60-80mls/kgm

1. Restore circulating volume:

- Insert wide-bore peripheral cannula
- Warmed crystalloid, ?colloid, blood
- normal blood pressure and urine output >30 ml/ h
- Monitor central venous pressure

2. Request laboratory investigations

- ❑ **FBC, PT, APTT, fibrinogen**
- ❑ Take samples at earliest opportunity.
- ❑ Repeat after blood component infusion. or after 1/3 blood volume replacement

3. Maintain Hb >8g/dl

- ❑ Fully cross-matched
- ❑ Un- crossmatched ABO group-specific, When blood group known
- ❑ Un- crossmatched group O Rh negative:
 - In extreme emergency
 - No more than 2 units
- ❑ Rh positive is acceptable if patient is male or postmenopausal female
- ❑ Use blood warmer and/or rapid infusion device if flow rate >50 ml kg/h in adult

4. Maintain platelets $> 75,000 / \text{mm}^3$

- $> 100,000 / \text{mm}^3$ for multiple/CNS trauma or if platelet function abnormal
- $> 50,000 / \text{mm}^3$ for other situations.
- (six units platelets) will raise the count by approximately 60,000

5. Maintain PT & APTT < 1.5

(mean control)

- ❑ Give **FFP** 12-15 ml/kg (4 units for an adult) guided by tests
- ❑ Fibrinogen deficiency develops early when plasma-poor red blood cells used for replacement
- ❑ Fibrinogen < **50** mg/dL. strongly associated with microvascular bleeding
- ❑ PT/APTT >1.5 x (mean normal value) correlates with increased microvascular bleeding

6. Maintain Fibrinogen > 100 mg/dL.

- ❑ If not corrected by FFP give cryoprecipitate (2 packs of pooled cryoprecipitate for an adult).
- ❑ Cryoprecipitate rarely needed except in DIC.

7. Avoid DIC

Although rare, mortality is high

- ❑ Treat underlying cause (shock, hypothermia, acidosis)
- ❑ Platelets may be given if counts are less than 5,000/mm³
- ❑ FFP

Definitive diagnosis

- ❑ Thrombocytopenia
- ❑ Prolongation of PT and aPTT
- ❑ A low fibrinogen concentration
- ❑ Increased levels of fibrin degradation products, (FDPs) including D-dimer , fibrin split products" (FSPs)

8. Monitor and document the following:

- a.** Continuous VS, arterial or Non-invasive BP
- b.** CoreTemp (nasoesophageal, bladder or pulmonary artery catheter) every 30 minutes
- c.** Lab data, coagulation studies, chemistry and blood gas profiles.
- d.** Record times and volumes of colloids, crystalloids and drugs infused
- e.** Record output from all tubes and ongoing estimated blood loss from all sources

Is the patient still bleeding?

Novo Seven can be given!!!!

NovoSeven (Recombinant VIIa)

- ❑ It is recombinant human coagulation Factor VIIa
- ❑ promoting hemostasis by activating the extrinsic pathway of the coagulation
- ❑ a vitamin K-dependent glycoprotein consisting of 406 amino acid
- ❑ 1200µg mg(60 KIU) Vial
- ❑ 2400µg (120 KIU) Vial
- ❑ 4800µg (240 KIU) Vial

Uses of Novo Seven

- If (a) the patient has near normal coagulation, or if the coagulopathy is not controlled
- (b) the surgeon is confident that major bleeding sites are controlled as best as possible.
- (c) the patient is still bleeding heavily
- Then Novo Seven (Recombinant VIIa) should be given at a dose of **50µg/kg**
 - In this situation appropriate fibrinogen top up with 2 to 4 units of cryoprecipitate and 2 units FFP may be given to ensure adequate substrate formation

Complications of Massive Blood Transfusion

- ❑ Blood Volume Replacement : **over or under**
- ❑ Transfusion requirements should be based on the patient's physiologic needs, defined by their oxygen consumption
- ❑ Thus transfusion should be guided by hemodynamic stability, PvO₂ and ER

$$ER = \frac{C_aO_2 - C_vO_2}{C_aO_2}$$


- If Hb > 10g/dl transfusion is rarely indicated.
- If Hb < 7g/dl transfusion is usually necessary.
- ❑ tissue oxygen tension, reflected by the PvO₂, or mixed venous partial pressure of oxygen (normally 45mmHg)
- ❑ (critical level 23mmHg)

- **Thrombocytopenia**
- **Coagulation Factor Depletion**
- **Oxygen Affinity Changes**
- **Hypocalcaemia**
- ***Hyperkalemia**
- **Acid/Base Disturbances**
- **Hypothermia**
- **Acute Respiratory Distress Syndrome (ARDS)**

The etiology of ARDS is as yet not fully understood, but various risk factors have been identified. Both under- and over-transfusion are associated with an increased risk of ARDS, as is albumin < 3.0g/l.

Infectious complications

- **Infectious Agents** can be passed along with blood transfusion as well.
 - Hepatitis
 - AIDS
 - Other viral agents (CMV, EBV, HTLV)
 - Parasites and bacteria



It is emphasized that, if avoidable deaths are to be prevented, surgeons, anesthesiologists, hematologists and blood-bank staff need to communicate closely in order to achieve the goals of secure haemostasis, restoration of circulating volume, and effective management of blood component replacement

Thank You