Specific indications, including Hb and platelet count triggers, can help clinical decision making.

- If $\text{Hb} < 7 \text{ g/dL}$ – often appropriate to transfuse erythrocytes.
- If $\text{Hb} > 10 \text{ g/dL}$ – rarely appropriate to transfuse erythrocytes.
- Oral iron therapy is preferable to transfusion in iron deficient patients.
- Plasma is used to treat plasma protein deficiencies.
- Platelets are appropriate when there is bleeding and thrombocytopenia; thrombocytopenia ($< 10 \times 10^9/L$) due to marrow suppression; neonates with thrombocytopenia or patients undergoing neurosurgery with platelet counts $< 50–100 \times 10^9$.

- Tranexamic acid and DDAVP may play a role in haemostasis, even during thrombocytopenia.
- Tranexamic acid reduces transfusion requirement in massive transfusion.
- Iron should be given in preference to transfusion in patients with iron deficiency.
4.1 ERYTHROCYTES

Erythrocytes are only administered dependent upon the patient’s symptoms, age and cardiovascular status. The most important questions to consider in the decision making for transfusion are:

- Could the patient compensate for the existing anaemia (cardiovascular status)?
- How intense and how much is the patient bleeding?
- Is there an increased use of O2 (temperature, cold shiver, sepsis)?
- Are there signs of atherosclerosis (brain, heart, vessels, kidney)?
- What is the state of tissue perfusion (release of O2)?

4.1.1 Haemoglobin Thresholds

The decision to transfuse erythrocytes should never be based on an Hb or Hct value only. Primary diagnosis, modifying clinical circumstances, functional capacity, ability to tolerate anaemia and availability of blood components are all relevant factors in the decision to transfuse.

**Hb≤6 g/dL (Hct 20%):**

Consider a transfusion if the Hb ≤ 6 g/dL (Hct 20%) in case of:

- Chronic asymptomatic anaemia.
- Acute blood loss in healthy person; < 60 years, ASA I, normovolaemic, blood loss from 1 location.

NOTE: Most patients do cope well with a low Hb (down to 6-7g/dL). For these patients, normalisation of the Hb is not needed. Functional impairment, e.g. organ failure, may develop at lower Hb values and transfusion may be justified.

**Hb≤7 g/dL (Hct 24%):**

Consider a transfusion at a Hb≤7 g/dL (Hct 24%) in case of:

- Acute blood loss in healthy person; > 60 years, ASA I, normovolemic, blood loss from 1 location.
- Acute blood loss in healthy person < 60 years, normovolemic and blood loss at more locations (poly-trauma).
- As pre-operative minimum; < 60 years, expected blood loss > 500 mL.
- Patient has sepsis.
- In the post-operative phase (uncomplicated) after open heart surgery.
- ASA II an III patient; uncomplicated.

**Hb≤8 g/dL (Hct 27%):**

Consider transfusion when the Hb≤8 g/dL (Hct 27%) in case of:

- ASA IV patient.
- Patient is not capable to increase the cardiac output.
- Patient with serious cardiopulmonary disease.
- Patient with cerebrovascular symptomatology (ischaemia).

**Hb≤10 g/dL (Hct 33%):**

- Hb of 10g/dL is well tolerated and transfusion above this value is not required.

4.1.2 Special Considerations

**Newborn and Children**

Erythrocyte transfusion is indicated in the following circumstances:

- During the first 24 hours post partum, a capillary haemoglobin level < 10 g/dL and clinical symptoms of anaemia (organ failure).
- During ECMO and a Hb level < 10 g/dL.
- During oxygen application and a Hb level < 9 g/dL.
- Stable premature, younger than 4 weeks and a Hb level < 8 g/dL.
- Stable premature, older than 4 weeks and a Hb level < 6.5 g/dL.
- A child (not neonate) will generally tolerate a lower Hb than an adult.
Critical Bleeding and Massive Transfusion

Critical Bleeding has many definitions:
- loss of one blood volume over 24 hours or
- the need to use 10 units of red cells or
- half the blood volume in 4 hours or
- bleeding at > 150 mL per minute.

Critical bleeding should be managed by a critical bleeding protocol which includes clinical assessment and laboratory results such as Hb, coagulation and acid-base measurements.

Major Bleeding:

For any blood loss of 20–25% of the blood volume, volume should be replaced by colloid or crystalloid solutions. Depending on the clinical situation (e.g. presence of organ failure) and the Hb level, in addition to volume supplementation, erythrocytes may be given (see chapter 13).

4.1.3 The Role of Iron

Many causes of anaemia are complicated by iron deficiency due to chronic blood loss, inadequate intake or co-morbidities. Low ferritin (less than 20-30 µg/L or determined by local laboratory reference ranges) is diagnostic of iron deficiency; however in patients with inflammatory conditions or chronic illness, the ferritin may be within normal range (up to 60 in children and 100 in adults) despite iron deficiency. Microcytosis (low MCV) may be due to iron deficiency however there are several other common causes (e.g. thalassaemia) and it cannot be relied on for diagnosis. Provided the patient has a functional bone marrow, a trial of full dose oral iron replacement therapy will cause an increased reticulocyte count within 1–2 weeks and may be diagnostic.

Oral iron therapy is preferable to transfusion in patients with iron deficiency.

4.1.4 Indications for whole blood

Indications for whole blood:
- Red cell replacement in acute blood loss with hypovolaemia, when replacement fluids are not available
- Exchange transfusion
- Patients needing red cell transfusions where red cell concentrates or suspensions are not available

Generally, erythrocytes are the product of choice for anaemia correction and improving oxygen carrying capacity.

Contraindications

- Risk of volume overload in patients with:
  - Chronic anaemia.
  - Incipient cardiac failure.
- Whole blood which has been stored at 2–6°C, or stored at room temperature for > 24 hours does not contain useful platelets or adequate labile clotting factors (e.g. FVIII). Whole blood should not be relied upon when trying to replace these blood components.

4.1.5 Hb AND Hct CONVERSION

Approximate conversion values for normocytic patients without significant haemolysis:

<table>
<thead>
<tr>
<th>Hb (g/L)</th>
<th>Hb (g/dL)</th>
<th>Hb (mmol/L)</th>
<th>Hct (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>4</td>
<td>2.5</td>
<td>14</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>3.1</td>
<td>17</td>
</tr>
<tr>
<td>60</td>
<td>6</td>
<td>3.7</td>
<td>20</td>
</tr>
<tr>
<td>70</td>
<td>7</td>
<td>4.3</td>
<td>24</td>
</tr>
<tr>
<td>80</td>
<td>8</td>
<td>5.0</td>
<td>27</td>
</tr>
<tr>
<td>90</td>
<td>9</td>
<td>5.6</td>
<td>30</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>6.2</td>
<td>33</td>
</tr>
<tr>
<td>110</td>
<td>11</td>
<td>6.8</td>
<td>36</td>
</tr>
</tbody>
</table>

Alternatively use these formulae:

\[ Hb \text{ (g/dL)} = Hct \times 3 \]

The constant depends upon the method of measurement and varies between 2.7 – 3.4.

\[ Hb \text{ (mmol/L)} = 0.621 \times Hb \text{ (g/dL)} \]

4.2 PLASMA

Indications:
- Bleeding or risk of major blood loss with demonstrated combined coagulation factor deficiency (massive blood loss, L-asparaginase therapy, severe liver disease, disseminated intravascular coagulation).
- Plasmapheresis in thrombotic thrombocytopenic purpura (TTP) and haemolytic uraemic syndrome (HUS).
  - Albumin may be a suitable substitute in TTP and HUS.
- Coagulopathy caused by envenomation from snake bites. Some snake venoms contain coagulation factors which often disrupt normal coagulation leading to mucocutaneous bleeding.
and sometimes thrombosis. Antivenom is the most potent therapy, which replacement of plasma clotting factors is important supportive care. Measurement of coagulation parameters may guide therapy.

- Isolated Factor deficiency when no suitable concentrate exists e.g. Factor V deficiency, F XIII deficiency.

**Contraindications:**
- Hypovolaemia by itself.
- Routine in (major) surgical operations.
- Immunodeficiency.
- Sepsis in newborns.
- Diet support / recuperation / parenteral nutrition.

### 4.3 PLATELETS

**Indications:**

*To treat bleeding:*
- Thrombocytopenia as a consequence of bone marrow insufficiency or abnormal platelet function with active moderate or severe bleeding.
- Massive blood loss and a platelet count < 50 x 10^9/L.

**Prophylaxis:**
- Prophylactic platelet transfusion is often appropriate for patients with thrombocytopenia as a consequence of bone marrow insufficiency (e.g. chemotherapy) and a platelet count of < 10 x 10^9/L.
- Higher thresholds may be relevant in certain clinical situations e.g.: Patients with platelet defects and risk of bleeding < 20–50 x 10^9/L and patients undergoing neurosurgical procedures < 50–100 x 10^9/L.
- Neonates often require higher platelet count:
  - Well premature baby 20 x 10^9/L.
  - Birth weight < 1500 g and ill 50 x 10^9/L.
- Overt bleeding/surgery 50 x 10^9/L.
- Prior to exchange transfusion < 100 x 10^9/L (during or after exchange transfusion).

**Contraindications**

Platelets should not be given to patients with platelet destruction such as:
- immune thrombocytopenic purpura (ITP);
- thrombotic thrombocytopenic purpura (TTP) and
- heparin-induced thrombocytopenia (HIT) unless there is life-threatening haemorrhage, in which case high dose steroids (or alternative) should be given in combination with platelets.

### 4.3.1 Haemostasis medications

There is no substitute for platelet transfusion for a patient with bleeding due to thrombocytopenia.

When platelets are not available, haemostasis may be supported by:
- tranexamic acid or,
- intravenous desmopressin (DDAVP).

**Tranexamic acid** is anti-fibrinolytic. It may reduce bleeding in both patients with and without thrombocytopenia and is now part of standard therapy in early critical bleeding. It carries a thrombosis risk and should be used with caution in patients at risk of thrombotic complications. Tranexamic acid can be administered before or after platelet transfusions if required.

**DDAVP** causes platelets and endothelium to release endogenous factor VIII (FVIII). This may assist haemostasis independent of platelets, particularly in patients with FVIII or vWF deficiencies. DDAVP has not been shown to reduce bleeding in patients without haemophilia or von Willebrand’s disease. Flushing and plasma sodium changes are the most common adverse events. Thrombosis is a risk for any medication which increases haemostatic potential.