antibody level dramatically, leading to the rapid destruction of transfused cells.

- At 5–10 days post-transfusion, patients present with fever, falling haemoglobin levels (or an unexpectedly poor rise in haemoglobin levels), jaundice and haemoglobinuria.
- A rise in bilirubin levels and positive direct antiglobulin test (DAT) will also be present.

**Development of antibodies to red cells in the patient’s plasma (alloimmunisation)**

- Transfusion of red cells of a different phenotype to that of the patient will cause alloimmunisation (e.g. development of anti-RhD in RhD-negative patients who have received RhD-positive cells).
- This is dangerous if the patient later receives a red cell transfusion, and can cause haemolytic disease of the newborn (HDN).

**Iron overload**

- Each unit of blood contains 250mg of iron, and those receiving red cells over a long period of time may develop iron accumulation in cardiac and liver tissues.
- Chelation therapy (with desferrioxamine) is used to minimise iron accumulation in those most at risk.

**Infection**

- The risk of becoming infected with HIV, hepatitis B or hepatitis C from transfusion is now small. However, since there is always the potential for unrecognised or unknown infection to be spread via transfusion, all non-essential transfusions should be avoided.
- Blood must be stored at the correct temperature at all times (at 1–6°C for up to 35 days if using citrate-phosphate-dextrose adenine anticoagulant or up to 21 days if using citrate-phosphate-double dextrose). Ideally each blood bag should be labelled with a temperature-sensitive strip that changes colour when the correct temperature for storage has been exceeded for a clinically significant period of time.

**Improving safety**

**Reducing transfusion errors**

- Introduce robust hospital transfusion protocols.
- Provide training for all staff involved in blood administration/taking samples for cross-matching.
- An understanding of transfusion medicine should be a core curricular component for all doctors in training.
- Improved information technology, such as use of a unique barcode on the patient’s wristband/blood sample and prepared blood, is important.
- Appoint specialist transfusion practitioners.

**Reducing unnecessary transfusion**

- Transfusion risks related to the use of allogeneic blood can be eliminated by the use of autologous blood (whereby patients collect and store their own blood for use in planned surgery). However, this practice is not risk-free.
- Ensure that blood products are only used when the patient is judged more likely to benefit from than be harmed by a transfusion.
- Always record in the patient’s notes the indication for giving blood.
- Adopt procedures such as checking for and correcting anaemia prior to planned surgery, stopping anticoagulants and antiplatelet drugs before surgery, minimising the amount of blood taken for laboratory samples, and using a simple protocol to guide when haemoglobin should be checked and when red cells should be transfused.
- Accept a lower haemoglobin concentration as a trigger for transfusion.
- Accept a lower post-transfusion target haemoglobin level.

---

### 1.8 Essential laboratory services

**Basic services provided in the laboratory and on the ward**

Whenever possible, the regional or central laboratory should procure the chemicals, prepare the reagents and standards, and distribute them with the necessary controls and approved testing procedure to district laboratories. Details on how to prepare the required reagents, standards and controls can be found in the 1995 WHO publication *Production of Basic Diagnostic Laboratory Reagents.*

For all small hospitals, the WHO recommends six basic investigations as an absolute minimum:

- haemoglobin or packed cell volume
- blood smear for malaria
- blood glucose levels
- microscopy of cerebrospinal fluid (CSF) and urine
- blood grouping and cross-matching
- for newborn care, blood bilirubin levels.

**Tests that can be performed on the wards**

These include the following:

- blood grouping
- rapid diagnostic test for *Plasmodium falciparum* (or urgent thick blood film for malarial parasites)
- urine microscopy (see Sections 5.6.A and 8.5)
- HIV rapid screening test
- HBsAg screening test
- "hot stool" examination (for *Entamoeba histolytica*)
- rapid haemoglobin (WHO paper-based method)
Tests to be performed in the laboratory
These include the following:
- thick and thin blood films for malaria and/or rapid diagnostic test for *Plasmodium falciparum*
- smears for *Leishmania* amastigotes
- rapid rk39 Ab test for *Leishmania* antibodies
- Ziehl–Neelsen sputum smears for TB
- Ziehl–Neelsen slit skin smears for leprosy
- Gram-stained smears
- haemoglobin estimation and platelets
- total and differential white cell count
- erythrocyte sedimentation rate (ESR)
- sickle-cell test
- HIV and hepatitis screening tests
- blood grouping and cross-matching
- urine deposits
- formol-ethyl acetate concentration and Kato-Katz thick smears for stool parasites.

Essential equipment
A functioning microscope is essential, and also saves time and therefore salary costs. Ideally a binocular instrument should be available, with ×10 eyepieces and ×10, ×40 and ×100 (oil immersion) objectives with integral illumination. LED light sources and options for using solar-powered batteries are now available.

A robust bench-top centrifuge is also needed. Ensure that lidded conical tubes (15 mL) can be used, and that there is an inner safety lid. A built-in timer and variable rotor speed are also desirable.

Haematological investigations

Haemoglobin
- Haemoglobinometer (BMS) visual comparator method: a useful method for testing small numbers of sample. No dilution or measurement of sample is required, and standard is included. Available from Cascade HealthCare Products Inc., USA (www.1cascade.com).
- DHT Hb523 haemoglobinometer: portable, battery-operated and requires 0.04% ammonia. Suitable when multiple investigations are required (www.haemoglobinometer.co.uk).
- Microhaematocrit centrifugation: if no other method is available this can be used for estimation. Note that there may be raised values caused by plasma loss (e.g. due to burns or dehydration).

White blood cell count
- Improved Neubauer haemocytometer: spare cover glasses, Turk’s solution (white blood cell diluent), 20-μl micropipette and hand tally counter are required.

Erythrocyte sedimentation rate (ESR)
- The Westergren method is recommended.

Differential white cell counts
- Thin blood film stained with Leishman’s/Rapyd Giemsa (pH 6.8). Tally counters are required.
- Film may also be used to examine red cell morphology for cases of suspected nutritional anaemia (e.g. iron deficiency).

Sickle-cell test
- A simple slide test using 2% sodium metabisulphite (prepared daily) will enable the morphology of sickled red blood cells to be seen, but cannot differentiate between sickle-cell disease and trait. The HbS solubility filtration test can differentiate sickle-cell anaemia from sickle-cell disease.

HIV test
- Rapid antibody tests are easy to use for blood transfusion screening purposes and for diagnostic screening. Many brands are available, their sensitivities and specificities vary, and brand use may depend on local availability.

Hepatitis B and C testing
- Rapid tests are available to detect HBsAg and anti-HCV antibody (refer to WHO Blood Safety Unit for details of appropriate tests).

Blood groups
- Blood grouping/cross-matching sera should be available.

Biochemical investigations
Low-cost, easily maintained equipment is urgently required in low-resource settings to measure plasma sodium and potassium levels. Hyponatraemia and hypokalaemia are common and dangerous conditions that need early detection and management. Important biochemical investigations include the following:
- Tests on whole blood, serum or plasma:
  - urea, creatinine and electrolytes
  - glucose
  - albumin
  - bilirubin
  - amylase
  - AST (aspartate aminotransferase)
  - ALT (alanine aminotransferase)
  - alkaline phosphatase
  - calcium
  - cholesterol
  - cholinesterase
  - iron
  - triglycerides.
- Urine clinical chemistry tests:
  - protein
  - glucose
  - bilirubin and urobilinogen
  - ketones
  - haemoglobin
  - nitrite
  - specific gravity.

Sections 1.1 to 1.7

Content
- CSF/gland/chancre aspirate/wet preparation for trypanosomes.
- The Westergren method is recommended.
Leishmaniasis
- For cutaneous leishmaniasis, a smear taken from the raised red edge of a lesion may be taken and stained with rapid Giemsa/Leishman’s (diluted with buffered water at pH 7.2) to demonstrate amastigotes.
- For suspected visceral leishmaniasis, haematological investigations plus an antibody detection test such as the Rapyd Leishman’s which utilises rk39 antigen are the most useful and safe investigations. Note that in HIV-positive individuals false-negative antibody test results are common.

African trypanosomiasis
- Immediate examination of a wet preparation and/or thick blood film stained as described above is the simplest way of diagnosing *Trypanosoma brucei rhodesiense* (if a chancre is present, a sample may be taken from between the edge and the centre of the lesion and examined as for blood).
- Gland fluid from a swollen posterior cervical gland may be examined (this is particularly useful in *T.b. gambiense*), with immediate examination for motile trypanosomes or stained as for blood.
- If these tests are negative, up to four microhaematocrit (MHCT) tubes of blood should be taken. These are centrifuged for 5 minutes, stuck to microscope slides and theuffy coat area examined for motile trypanosomes (Woo test).
- All samples must be examined as soon as possible to avoid parasite lysis.
- If the blood is positive for trypanosomes, or it is suspected that the patient has late-stage (stage II) CNS disease, a lumbar puncture must be taken and CSF examined microscopically within 30 minutes of the procedure in order to visualise trypanosomes. The number of white blood cells should be counted using a haemocytometer.

TB and leprosy
For suspected TB
- If possible, up to three consecutive morning sputum samples should be examined.
- The Ziehl–Neelsen (ZN) method of staining should be used.
- The addition of bleach to liquefy the sample may improve sensitivity, and lowers the risk of laboratory infection.

For suspected leprosy
- The ZN method of staining should be used on slit skin smears.

Urinary infections and renal diseases
Urine examination
- Urine “dipstick” tests are useful for detecting blood, protein, glucose, bilirubin, urobilinogen, infection, nitrites and white blood cells.
- A midstream urine (MSU) sample may be examined microscopically for the following:
  - *Schistosoma haematobium* ova (or terminal urine)
  - pus (white blood cells)
  - erythrocytes
  - casts
  - bacteria (suspected urinary tract infection).
- The addition of a drop of 1% methylene blue in physiological saline may aid microscopical examination.
- If urine is to be sent for culture, 20 mL of an MSU sample should be mixed with 3 mg of boric acid (a preservative).
- It is important to give instructions to ward staff on how to obtain an MSU sample, bag urine and suprapubic aspirate.
Ulcers and exudates
- For suspected bacterial (and fungal) infections, a smear of the pus or exudate should be stained with Gram stain.

Meningitis
- A Gram-stained CSF deposit may be useful in cases of suspected meningitis.
- The India ink stain is used for cryptococcal meningitis.

References
1 World Health Organization (1995) Production of Basic Diagnostic Laboratory Reagents. Can be obtained from WHO Regional Office, PO Box 1517, Alexandria.

1.9 Records, history taking and examination

Records
- Records can be held by patients or parents, or by the hospital, or both.
- If they are patient or parent held, they can be developed into health booklets containing advice on how to manage illnesses (possibly in the form of pictures for illiterate parents). Immunisation information, if included, should comply with national immunisation programmes.
- Hospital records need to be kept confidentially in a logical system for audit purposes, with easy access to previous notes.
- Discharge information and advice should be entered in the patient- or parent-held booklet.
- If possible, diagnoses should be coded and entered according to the International Classification of Diseases (ICD) or in accordance with local policy and coding.

Examination
The following basic equipment is required:
- stethoscope
- otoscope (if available)
- ophthalmoscope (if available)
- tendon hammer
- bright torch light (or mobile phone light)
- thermometer
- Pinard’s stethoscope or Sonicaid (a hand-held Doppler)
- microscope (if available).

Conducting the examination
- A triage nurse (see Section 1.10) can be helpful for making a preliminary assessment of patients. They can assess each patient and use the recorded body temperature, weight, general condition and pain score of the patient to decide how urgently he or she should be seen by the doctor.
- Do not rush the examination. A thorough examination is often needed, and taking time can help to gain the confidence of the patient and their family.
- If the patient is critically ill, quick action is required and questions can be asked later.
- Try to be gentle and avoid palpating a painful body part before everything else has been done. You want to avoid having a crying patient whom you cannot examine or auscultate.
- Small children and infants are best examined on the parent’s lap; older ones can be asked to lie down.
- In general, the examination of a child will follow the same systematic approach as in adults. However, you may need to be more opportunistic.

Essential emergency examination checklist
Always check the following in the order shown:
- Airway
- Breathing
- Circulation
- Disability
- Exposure.