# Blood collection: whole blood
# Apheresis
# Autotransfusion

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# A safe blood supply depends on:

- An optimal number of donors who donate blood regularly
- Growing the number of repeat donors, rather than new donors
- Education of donors regarding transfusion risks
- Selecting safe donors
- Performing blood grouping and testing all donations for TTIs
- Ensuring adequate donor, sample and donation identification and records
  - to make sure donations are properly labelled and blood can be traced from donors to recipients (hemovigilance)

# Blood donation

- There is no substitute for blood, thus it can only be replaced by blood donation
- Forms of blood collecting:
  - Whole blood
  - Apheresis
    - a technique by which a particular substance or component is removed from the blood, the main volume being returned to the donor’s circulation
  - Autotransfusion

# Types of blood donors

- Voluntary non-remunerated blood donors
  - Safest donation
- Directed donors
  - Give blood for a relative or friend
- Autologous donors = autotransfusion

| Type and Definition | Advantages | Challenges |
|---|---|---|
| Voluntary non-remunerated blood donors<br>•Recruited by the blood service<br>•Unpaid VNRBD<br>•Donate for any patient in need<br>•Ideally, return to donate regularly | •Usually preferred donation type<br>•Lowest rate of TTIs, particularly if become repeat donors<br>•May become regular donors ensuring a stable blood supply | •Requires system of donor recruitment and retention |
| Family replacement donors<br>•Recruited by a patient, or a family member who needs blood<br>•Blood donation goes into general inventory to "replace" units used for the patient<br>•May be family members of the patient, or other individuals paid or recruited by the family | •May recruit healthy individuals to become blood donors<br>•May become VNRBD after successful donation | •Usually have higher rates of TTIs, when compared to repeat VNRBD<br>•May be less likely to disclose health risks due to motivation to donate and lack of confidentiality<br>•Very often donate only once |
| Directed donors<br>•Recruited by a patient or their family members who needs blood<br>•Donation is used specifically for that patient<br>•If donation is not needed for intended patient, it may be discarded or placed in general inventory | •May recruit healthy individuals to become blood donors<br>•May provide rare blood group unavailable in the general donor pool<br>•May become VNRBD after successful donation | •Cannot be done if blood is urgently needed<br>•Complicated procedures to ensure selected donors are correct blood type, blood is sent to correct hospital |
| Autologous donors<br>•Patients donate their own blood prior to scheduled surgery<br>•Donation is used only for that patient and discarded if unused | •May provide blood if inadequate VNRBD<br>•May provide rare blood group unavailable in general donor pool | •Only possible in scheduled, elective surgery<br>•Patient/donor assumes risk of donation, and often starts surgery at a lower haemoglobin level<br>•Complicated to ensure blood is sent to correct hospital pre-operatively<br>•High wastage |

TTI = transfusion transmissible infections

# Bag systems for blood collection

- Sterile, closed system
- Polivinyl-chloride (PVC) plastic bag
  - Top and bottom bag for whole blood
    - The primary collection bag containing anticoagulant has an empty transfer bag connected to the top, and another transfer bag containing additive solution connected to the bottom.
- Apheresis bag
  - More complicated due to the technique

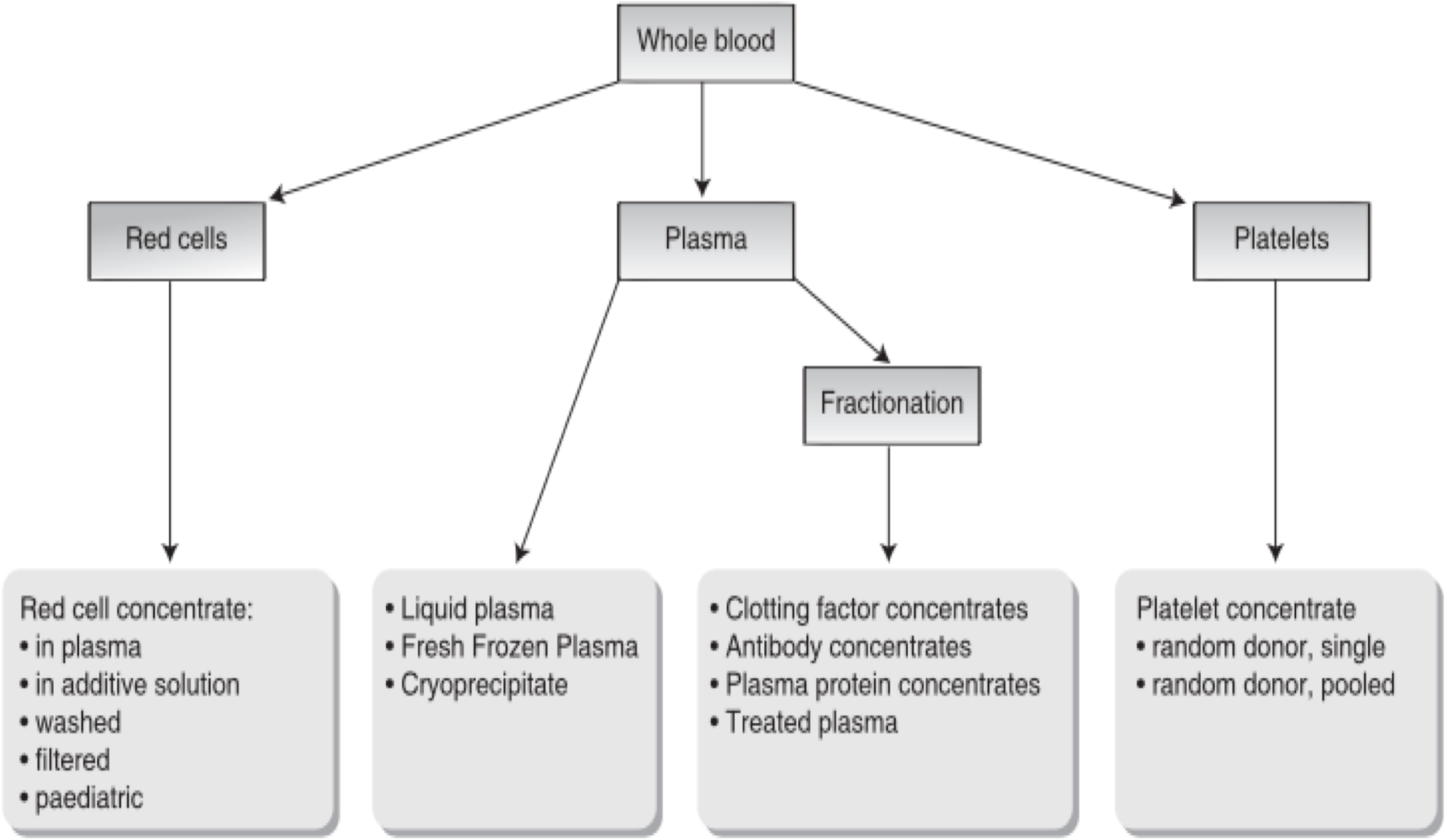
# Whole blood donation

- General steps of collecting:
  - Donor identification, administration, health and lifestyle questionnaire
  - Hemoglobin screen
  - Medical interview
  - Collection of whole blood
  - Processing
  - Storage

# Donor's screening

- The donation can not compromise the health of the donor, the health of the recipient, or the quality of the product
  - Standard procedures and criteria systems
  - Includes a medical history interview, a mini-physical examination of the donor (general appearance, vital signs-blood pressure, pulse), and a haemoglobin screen
  - Trained healthcare professionals make a one-on-one interview with the donor and check the questionnaire

# Processing whole blood into components



# Whole blood

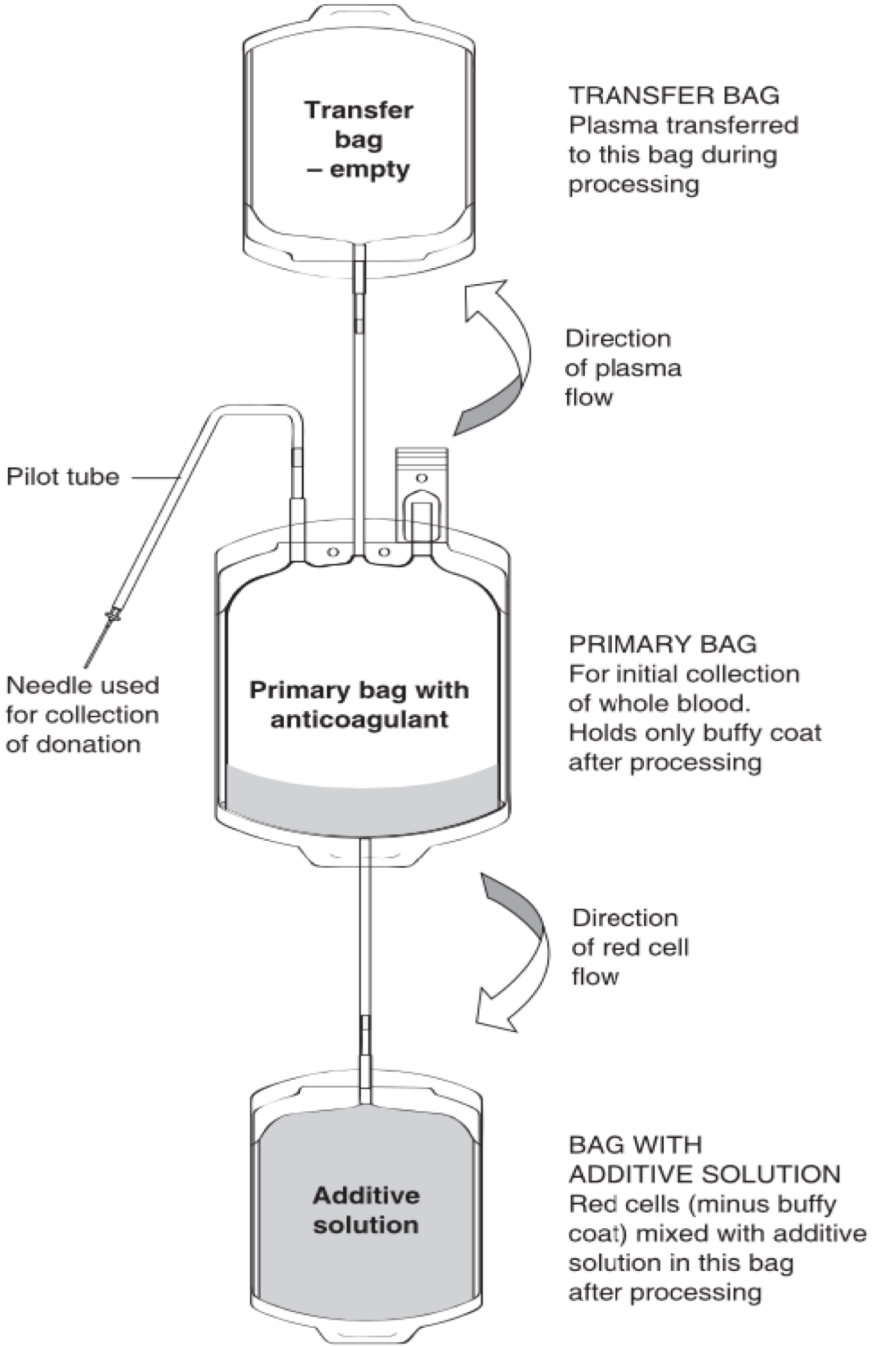
- Most commonly collection
- Each donation must have a unique identification number - hemovigilance
- Collecting blood volume: 450 ml ± 10%
  - A diversion pouch is part of the blood bag unit. This allows the first 30 ml of blood to be collected in a separate pouch for filling laboratory test tubes
- Maximum time of collecting is 12 mins

# General eligibility requirements for blood donors in Hungary

- Age: 18-65 (up to 60 years for new donors)
- Weight: min. 50 kg
- Haemoglobin level:
  - Females: 125-170 g/l
  - Males: 135-180 g/l
- The minimum interval between donations is 56 days
- The frequency of donations in 365 days is four times for females and five times for males

# Donations testing

- should be carried out on every donation
- Red cell serology testing (automated)
  - ABO and Rh typing
  - red cell antibody screening
- Transfusion transmissible infections (TTIs) testing including:
  - Hepatitis B virus (HBV)
  - Hepatitis C virus (HCV)
  - human immunodeficiency virus (HIV1/2)
  - syphilis

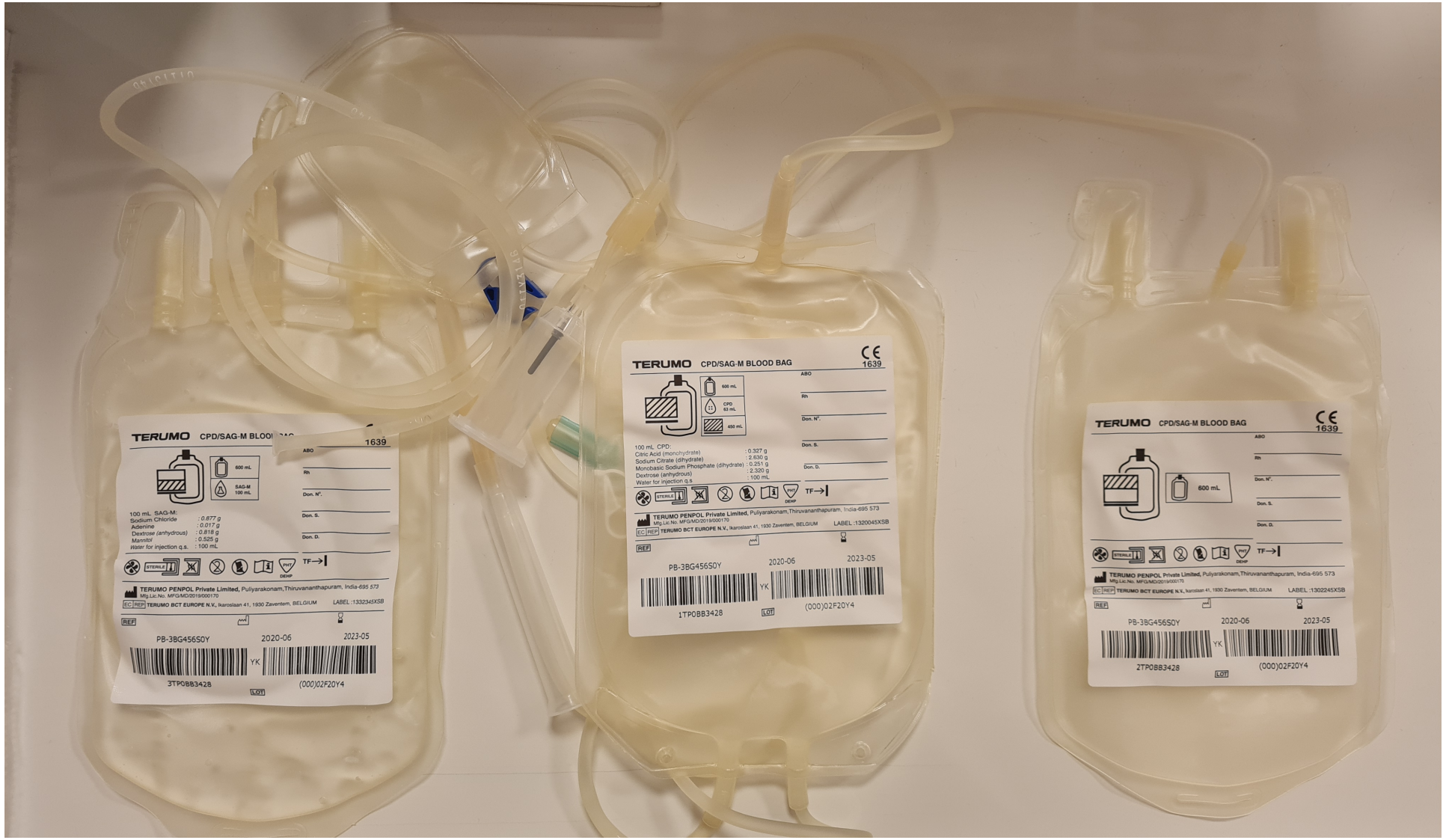


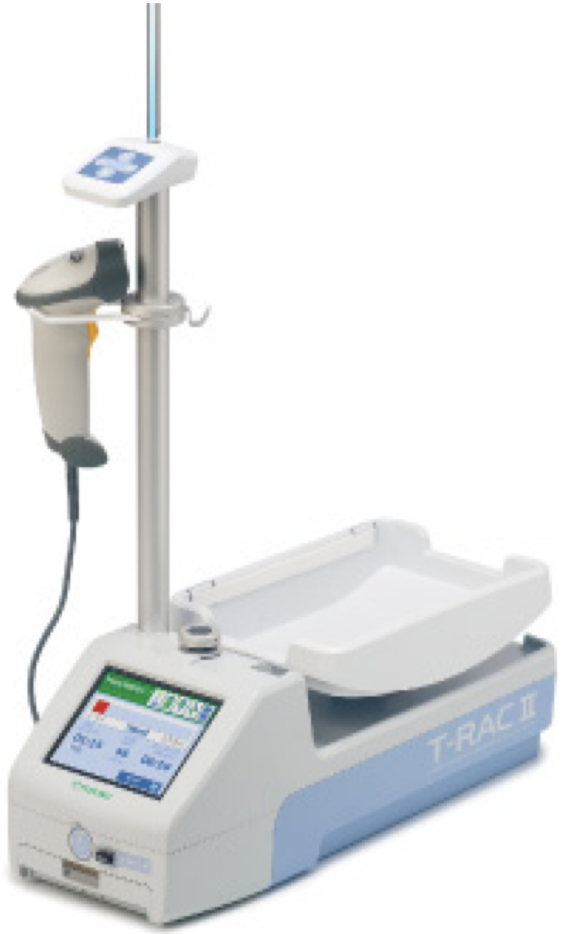

# Top and bottom bag

The primary bag contains an anticoagulant solution CPD. Typically this contains sodium citrate that prevents clotting, and citric acid (C), sodium phosphate (P), dextrose (D), that provide buffers and nutrients for enhanced red cell survival.

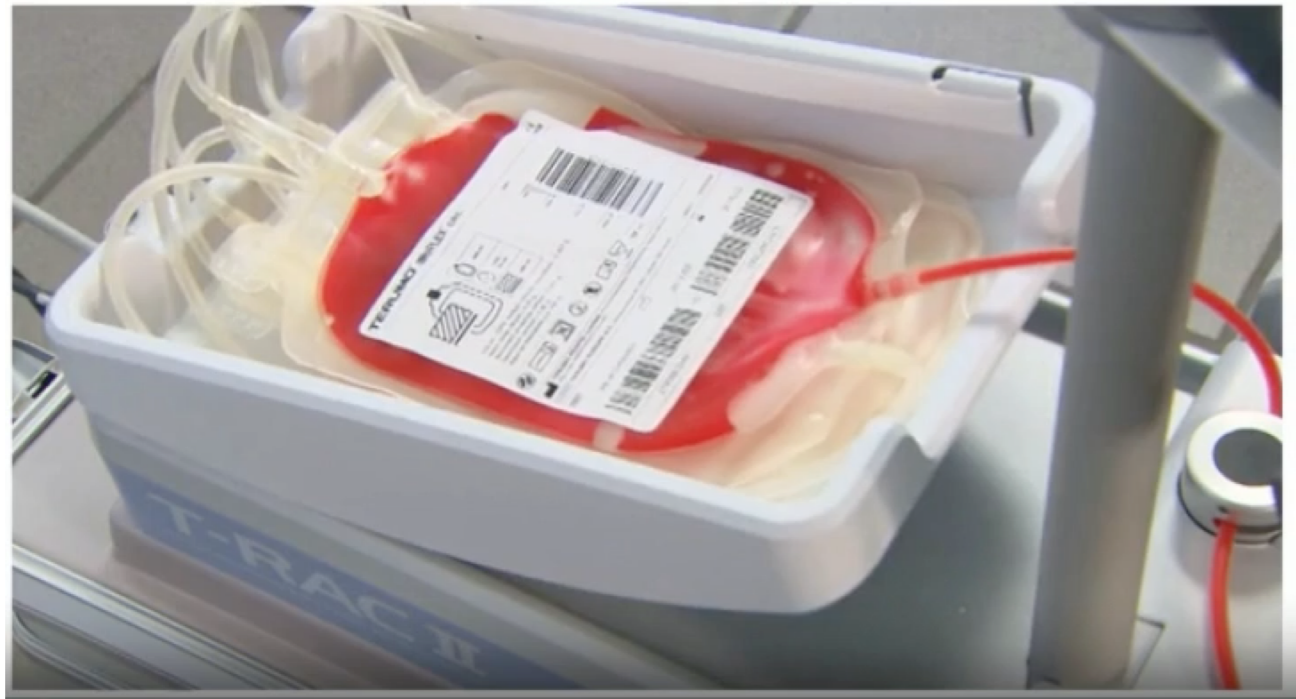
Additive solution is SAGM, contains saline (S), adenine (A), glucose (G) and mannitol (M).

# Top and bottom bag



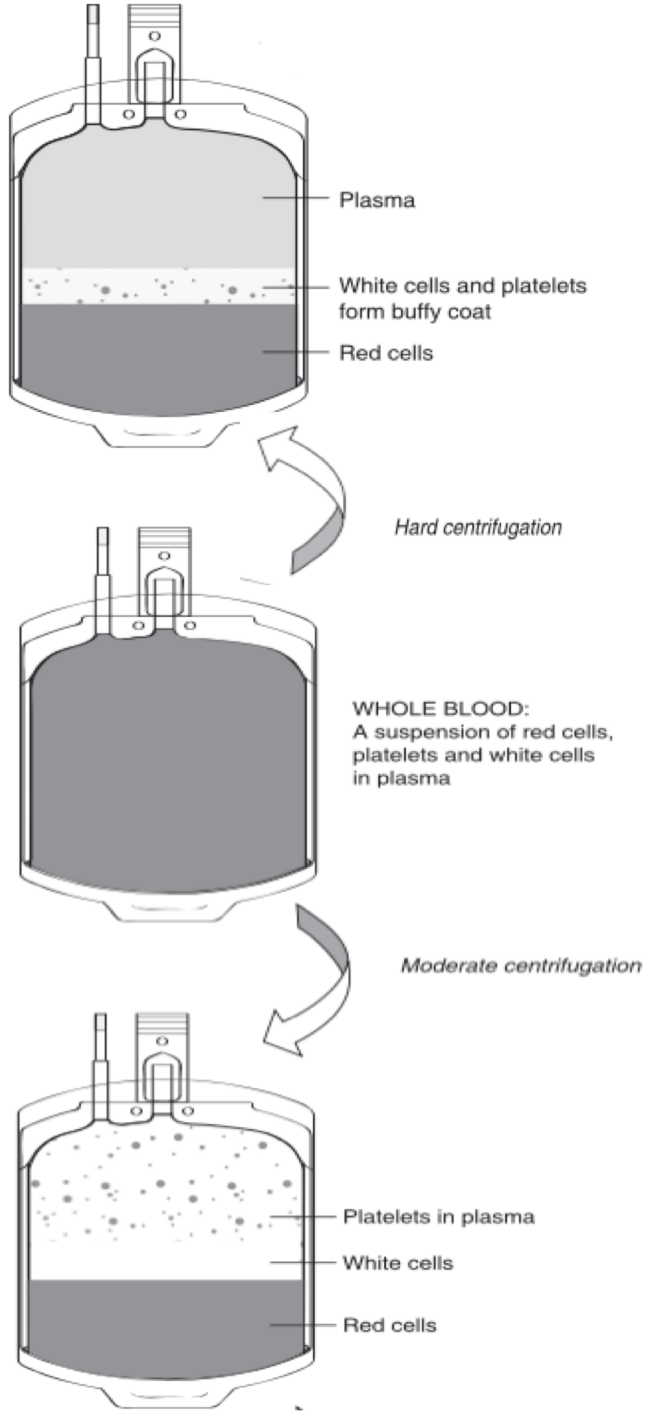

T-RAC II


TERUMO
Tue Apr 9, 2013, 14:02
450 ml
107 ml
0 ml
TOTAL ESTIM. TIME
04:26
FLOW RATE
108
ml/min
TIME ELAPSED
01:17
STOP
PAUSE


T-RAC II

# Whole bloods after collection

# Processing of whole blood




Centrifugation of whole blood determines the technique of processing:

- Patelet rich plasma
  - Moderate centrifugation
- **Buffy coat technique**
  - Hard centrifugation
  - Buffy coat is the layer between red blood cells and plasma that contains most of the white blood cells and platelets.

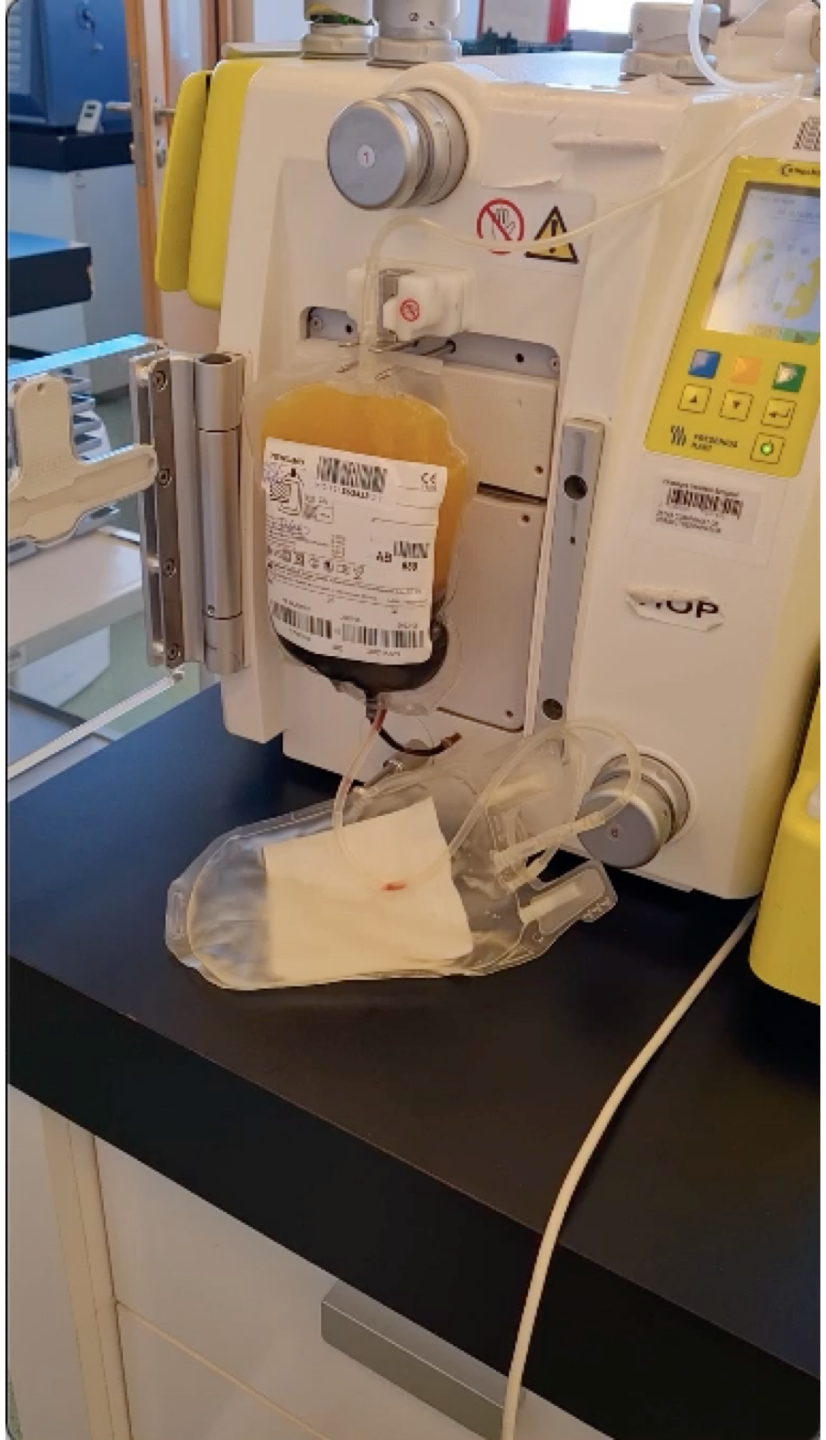
# Whole blood processing techniques

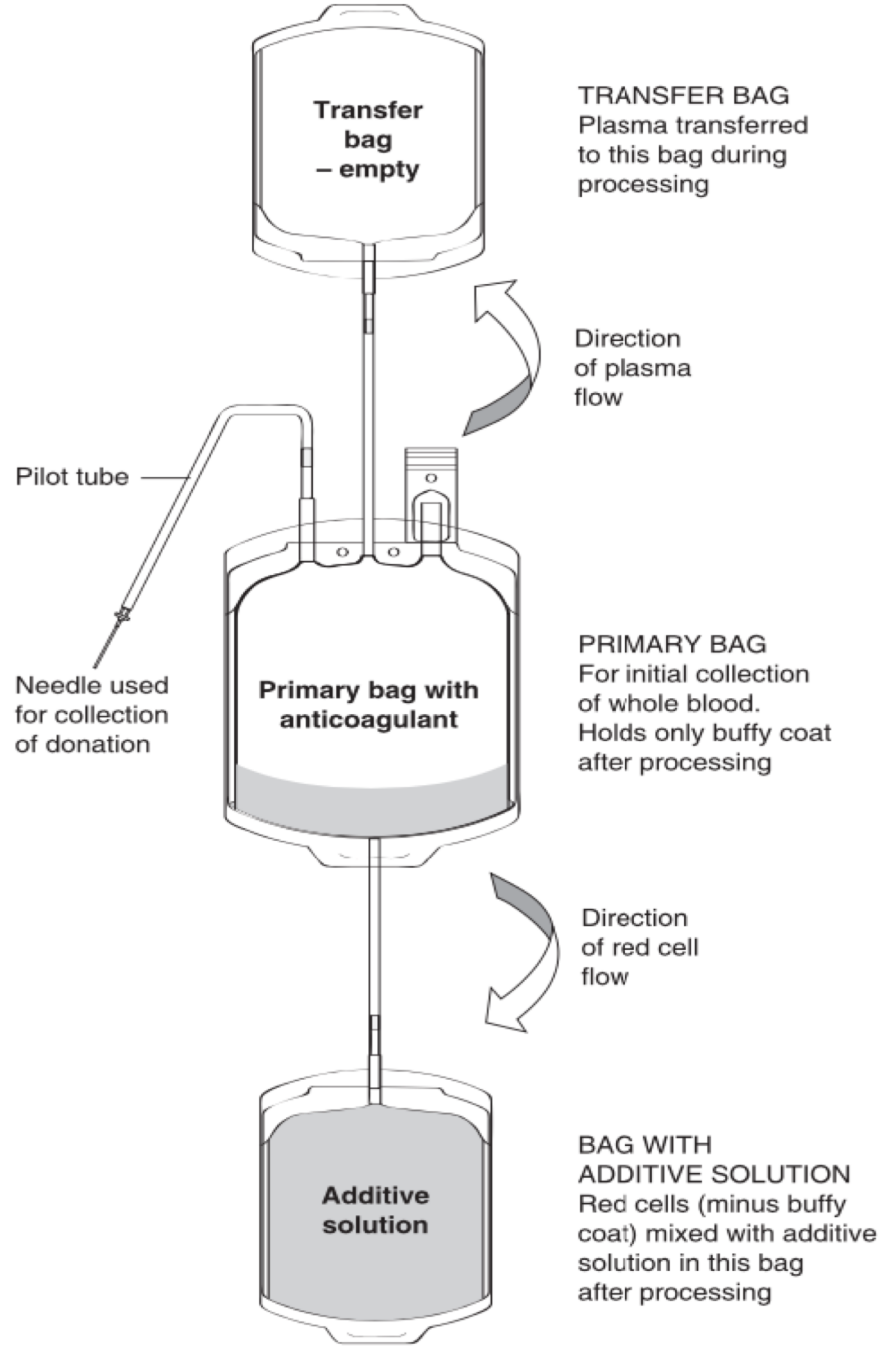
- Patelet rich plasma
  - Moderate centrifugation
  - Blood cell products have higher leukocyte contamination
  - Not maximize the volume of harvested plasma
  - Used in USA

- Buffy coat technique
  - Hard centrifugation
  - RCC contains fewer leucocytes
  - Reduces micro-aggregate formation during storage
  - The incidence of recipient febrile reactions is also lower (FNHTR)
  - Used in Hungary since the mid-1980s (in EU also)

# Centrifugation


CompoMat G5 is designed to efficiently and reliably automate the separation of whole blood units into blood components.
https://www.medicalexpo.com/prod/fenwal/product-70824-678913.html

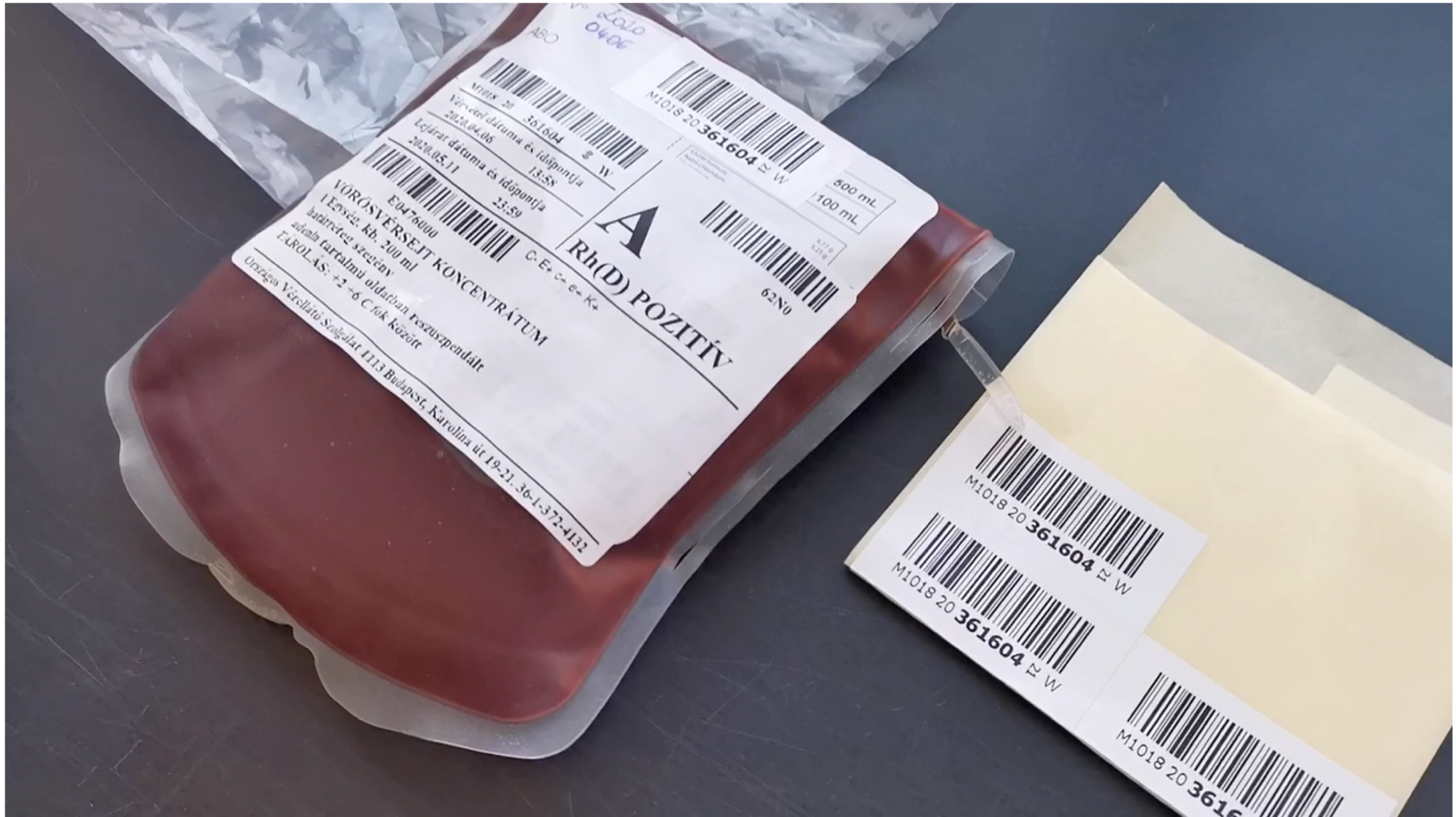



Transfer bag – empty
TRANSFER BAG
Plasma transferred to this bag during processing
Direction of plasma flow
Pilot tube
Needle used for collection of donation
Primary bag with anticoagulant
PRIMARY BAG
For initial collection of whole blood.
Holds only buffy coat after processing
Direction of red cell flow
Additive solution
BAG WITH ADDITIVE SOLUTION
Red cells (minus buffy coat) mixed with additive solution in this bag after processing

# Red cell concentrate, buffy coat removed, in additive solution (RCC, leucocyte-reduced)

- Volume: 230-300 ml (SAGM: 100 ml)
- Hematocrit: 60-70%
- Removal of the BC the red cell product contains less than $1{,}2 \times 10^9$ leucocytes/unit, and this is considered to be leucocyte-reduced

# RCC, macroscopic inspection

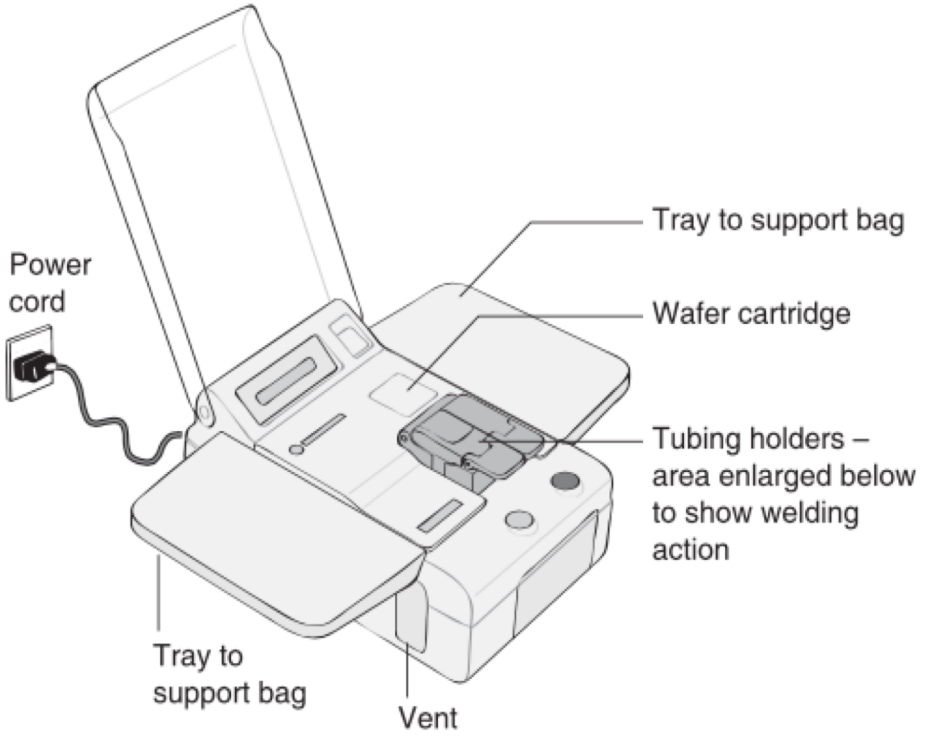


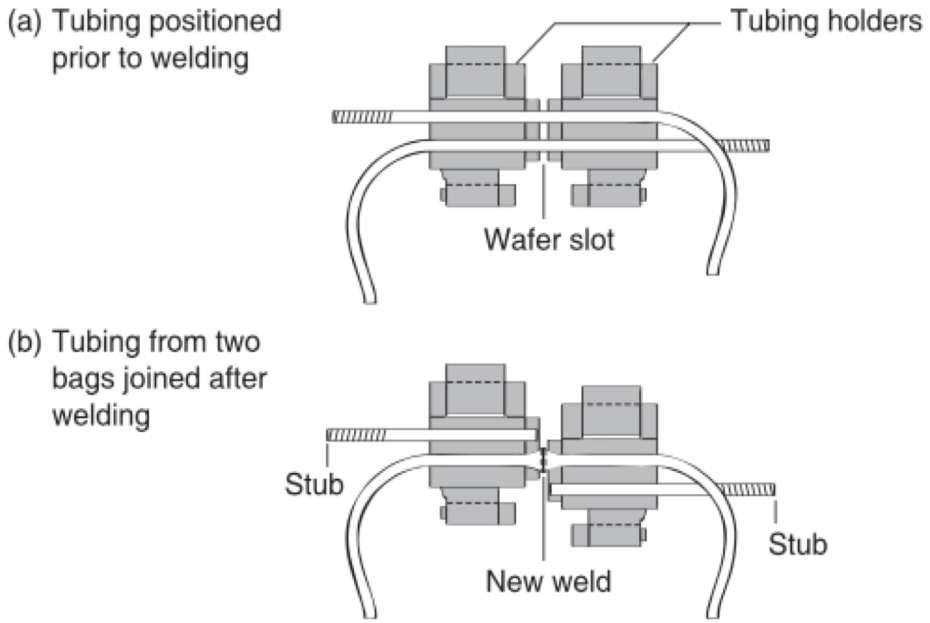
# Red cell concentrate, filtered (RCC, leucocyte-depleted)

- Filtered red cell concentrate contains < 1-5x$10^6$ white blood cell/unit
- Indications:
  - Polytransfusion patients after 2 FNHTRs
  - Transplant patients (before and after transplantation)
  - Haematology patients
  - Prevent the transmission of CMV

# Filtration of blood products

- Prestorage filtration
  - the unit of blood is filtered as soon as possible, preferably within 48 hours of donation
  - Less white cells and cytokines
- On demand filtration
  - filtering units only when requested
- In-line filter systems
  - designed to filter the whole blood donation prior to further processing or to filter the RCC after removal of the plasma and BC
- Add on filter systems
  - involve a separate bag with integral filter that is attached to the unit to be filtered by using a sterile connecting device. Due to SCD the shelf life of the component is unaffected.




Sterile connecting device (SCD) is used to attach a transfer bag to a primary blood bag without breaking the sterile integrity of the system

# Fresh frozen plasma (FFP)

- Freezing must be carried out within a maximum time of 24 hours from time of collection
- From the time of donation to the time of freezing, the donation must be kept at controlled room temperature (+22°C ± 2°C)
- The time to freezing the plasma to a core temperature below -30 °C should not exceed 1 hour from the start of freezing
  - Core temperature refers to the temperature of the centre of the unit - the warmest part of the plasma package during the freezing process.

# FFPs after separation but before freezing


# After freezing

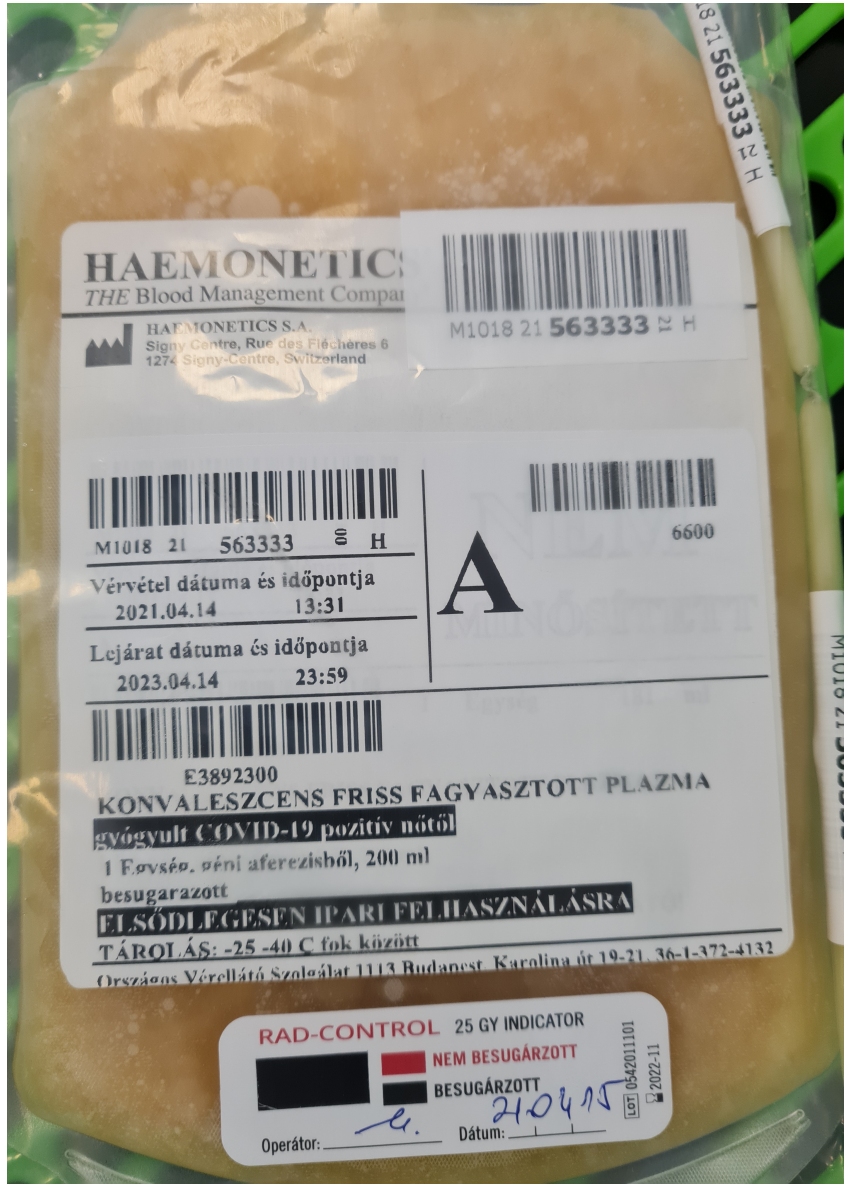
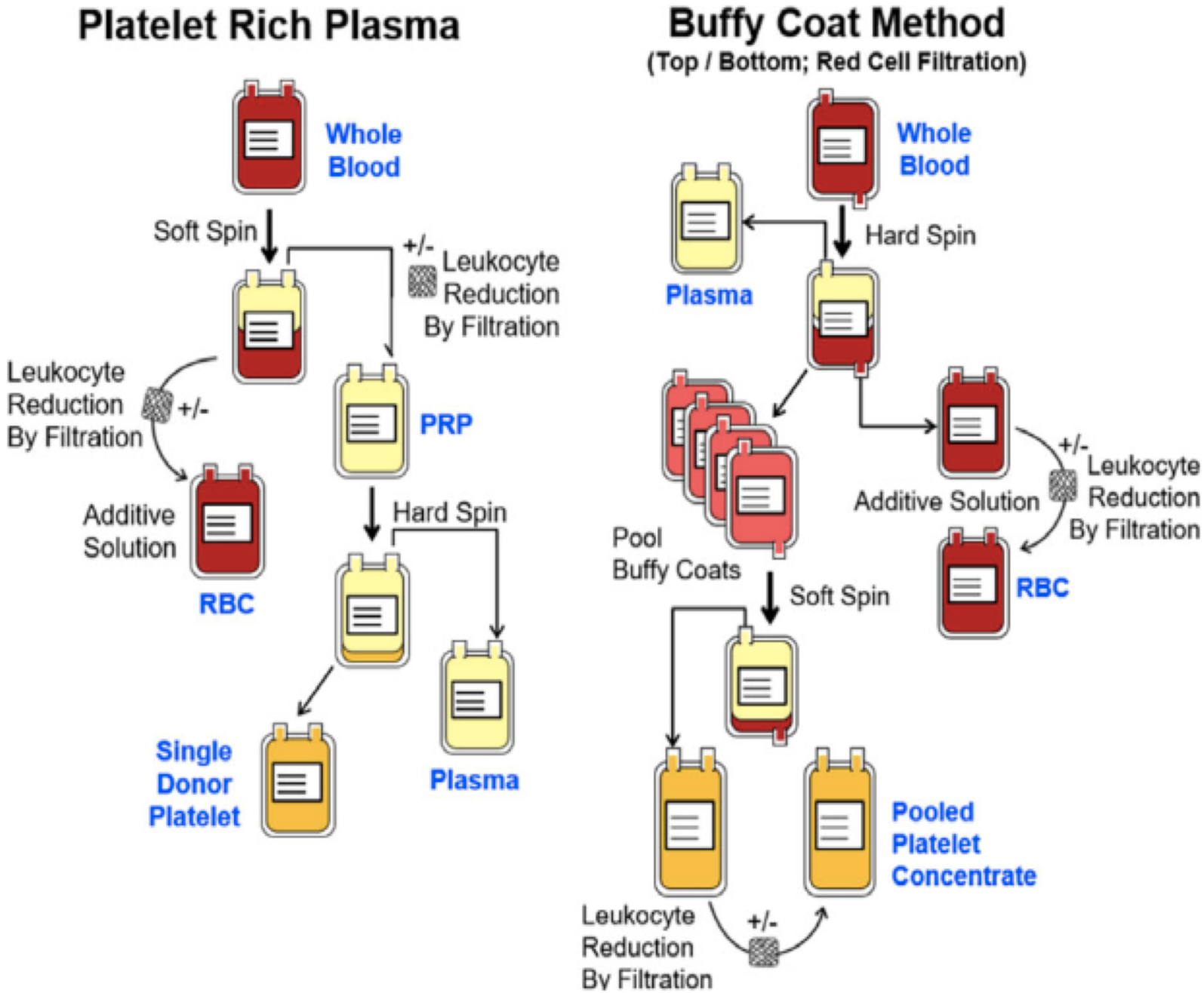



Plate freezers hold plasma units between two super-cooled plates to achieve freezing and uniform flat shape.

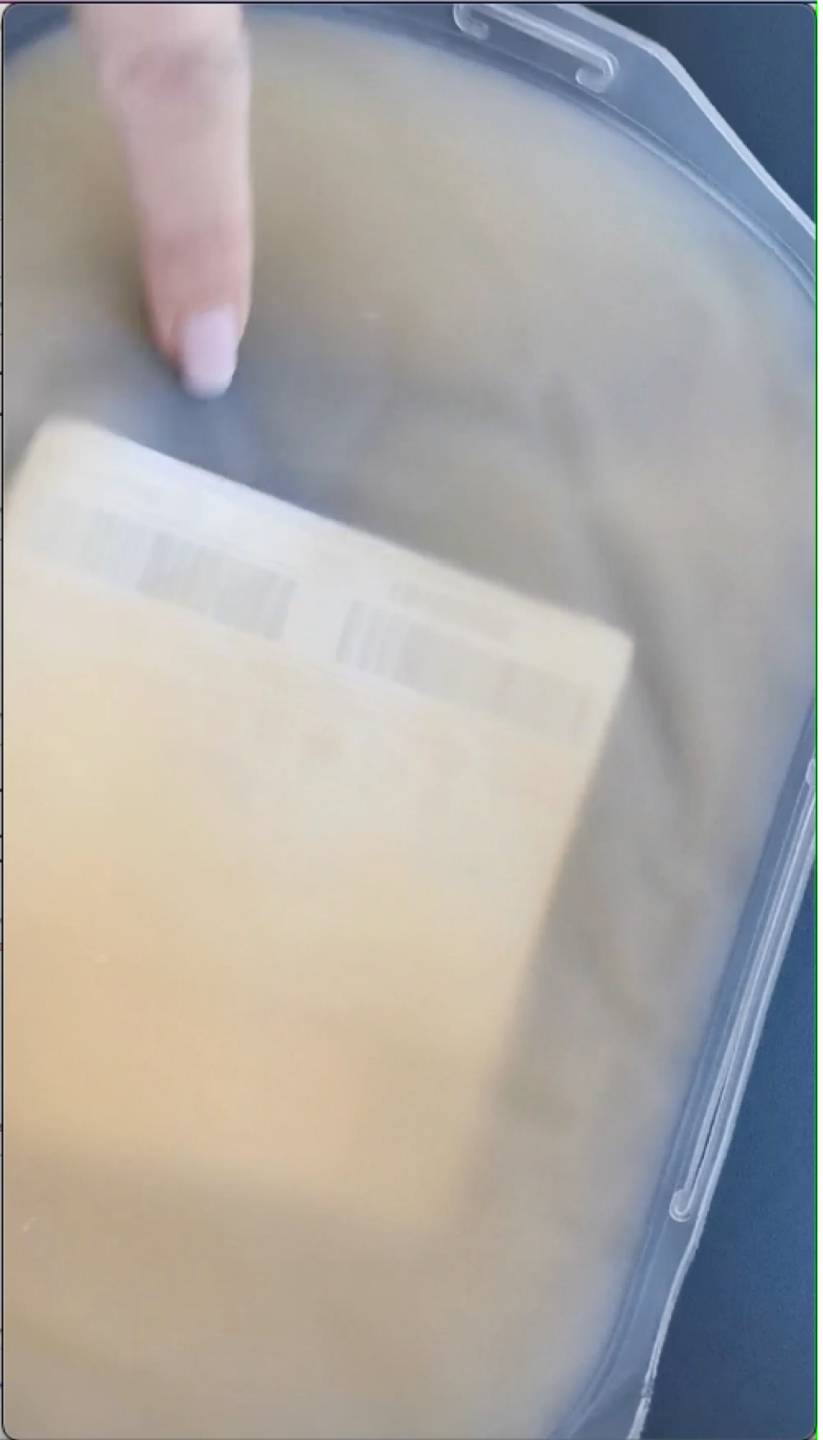
# Platelet concentrates

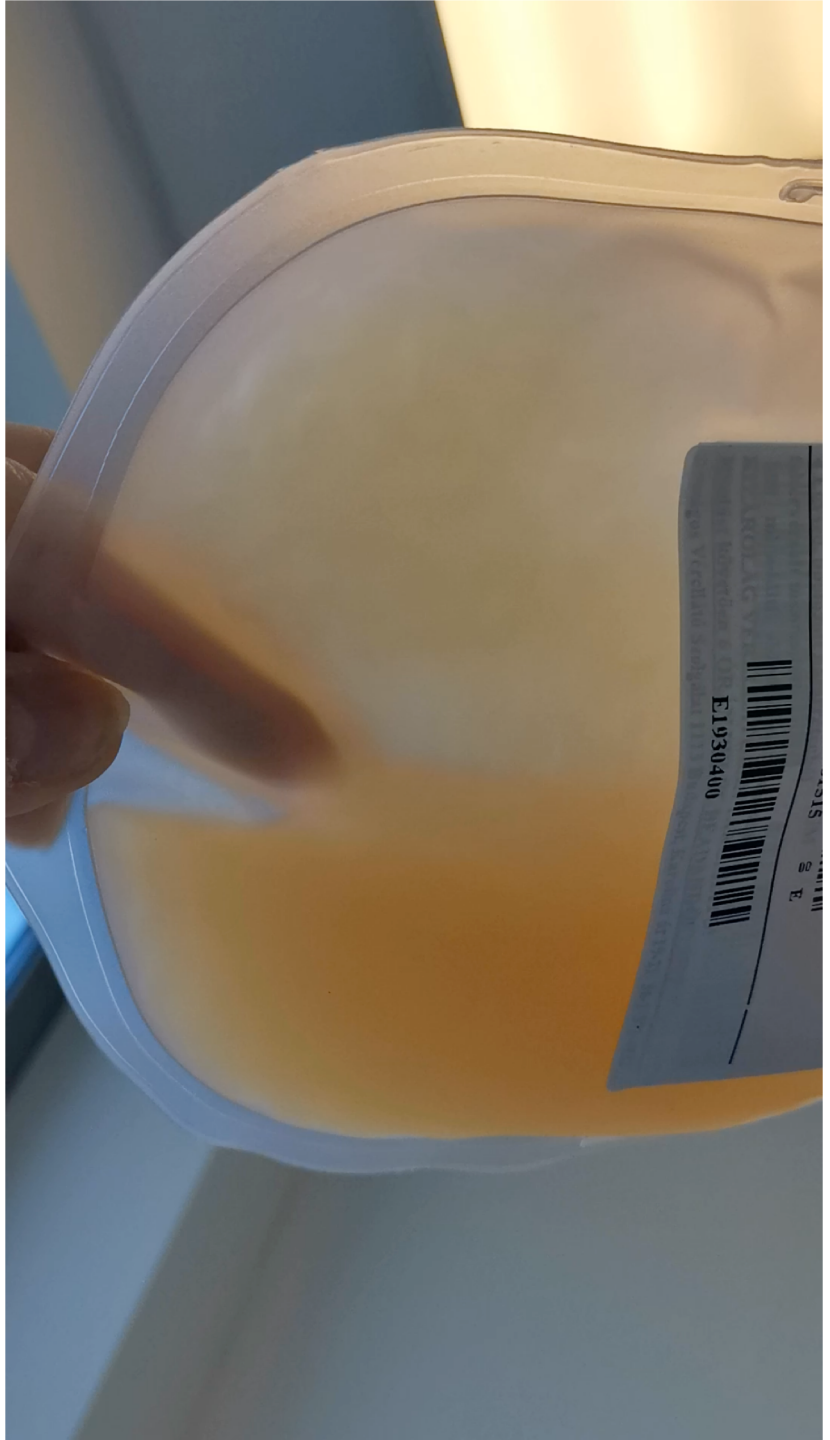
- Pooled platelet concentrate:
  - made from whole blood donations
  - Pooling 4 buffy coats
- Single donor platelet concentrate:
  - made from one donor using apheresis technology


Platelet Rich Plasma
Whole Blood
Soft Spin
+/-
Leukocyte Reduction By Filtration
Leukocyte Reduction By Filtration
+/-
PRP
Additive Solution
RBC
Hard Spin
Single Donor Platelet
Plasma
Buffy Coat Method
(Top / Bottom; Red Cell Filtration)
Whole Blood
Hard Spin
Plasma
Pool Buffy Coats
Additive Solution
+/-
Leukocyte Reduction By Filtration
RBC
Soft Spin
Pooled Platelet Concentrate
Leukocyte Reduction By Filtration
+/-

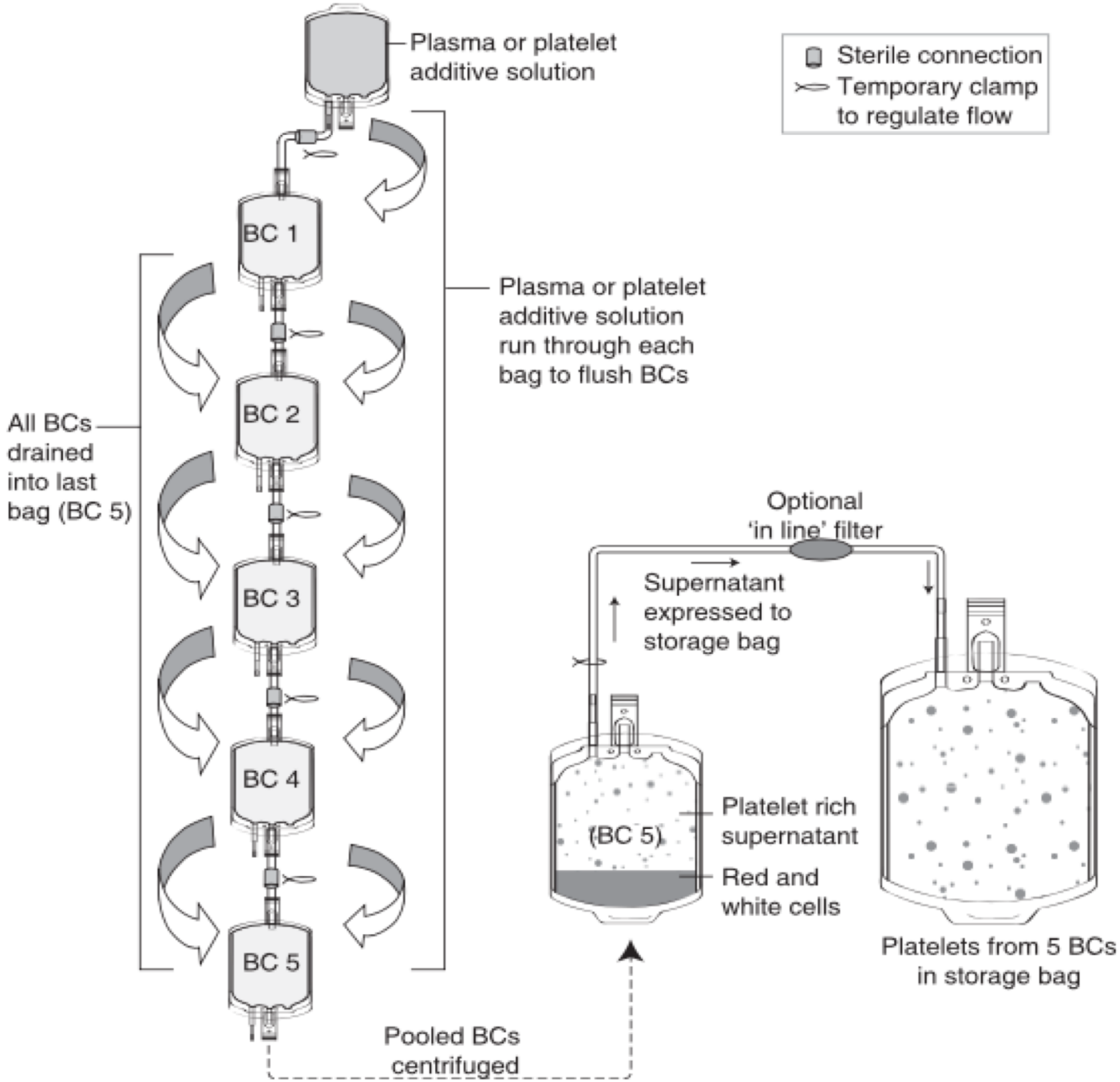
# Pooled platelet concentrate

- Prepared buffy coats (BC) are stored at 22°C ± 2°C without agitation until they are further processed into platelet concentrates, preferably within 48 h of donation
- Four BCs of the same ABO and RhD blood group may be pooled together
- The pool is diluted with platelet additive solution (PAS)
  - designed to maintain pH and platelet viability better than plasma
- The pooled product is equal to a 4 units platelet concentrate containing $2x10^{11}$ thrombocytes






Pooled PC, swirling phenomenon


Plasma or platelet additive solution
Sterile connection
Temporary clamp to regulate flow
BC 1
BC 2
BC 3
BC 4
BC 5
Plasma or platelet additive solution run through each bag to flush BCs
All BCs drained into last bag (BC 5)
Optional 'in line' filter
Supernatant expressed to storage bag
(BC 5)
Platelet rich supernatant
Red and white cells
Platelets from 5 BCs in storage bag
Pooled BCs centrifuged

# Pooled platelet concentrate, filtered

- Contains less than $1x10^6$ leukocytes/E
- Leuco-depleted platelet products are indicated:
  - decrease the frequency of recurrent febrile, non-haemolytic transfusion reactions
  - prevent alloimmunisation against human leucocyte antigens (HLA)
  - avoid transfusion-transmitted cytomegalovirus (CMV) infection

# Apheresis platelets (single donor platelets)

- Platelet apheresis of a single donor using automated cell separation equipment
  - In this procedure whole blood is removed from a donor and the apheresis machine harvests the platelets
  - All other components are returned to the donor
  - Donating more frequently than at whole blood
- Apheresis platelet product is leucocyte-depleted due to the collection procedure
- Contains 2-5x$10^{11}$ platelets/20 E

ComTec by Fresenius Kabi:

multi-procedural apheresis platform:

- Platelet collection
- Stem cell collection
- Therapeutic treatments

# Irradiated products

- Blood components that may contain viable lymphocytes could initiate graft vs. host disease (GvHD) in a recipient given the following circumstances:
  - Recipient on immunosuppressive drugs
  - Neonate (poorly developed immune system)
  - Recipient with immunodeficiency
  - Intrauterine transfusion
  - Component for transfusion is from close family member of recipient

# Transfusion-associated graft-versus-host disease (TA-GvHD)

- GvHD is an immune condition that occurs after transfusion when immune cells in the transfused blood (i.e. the graft) attack the tissues of the patient (the host).

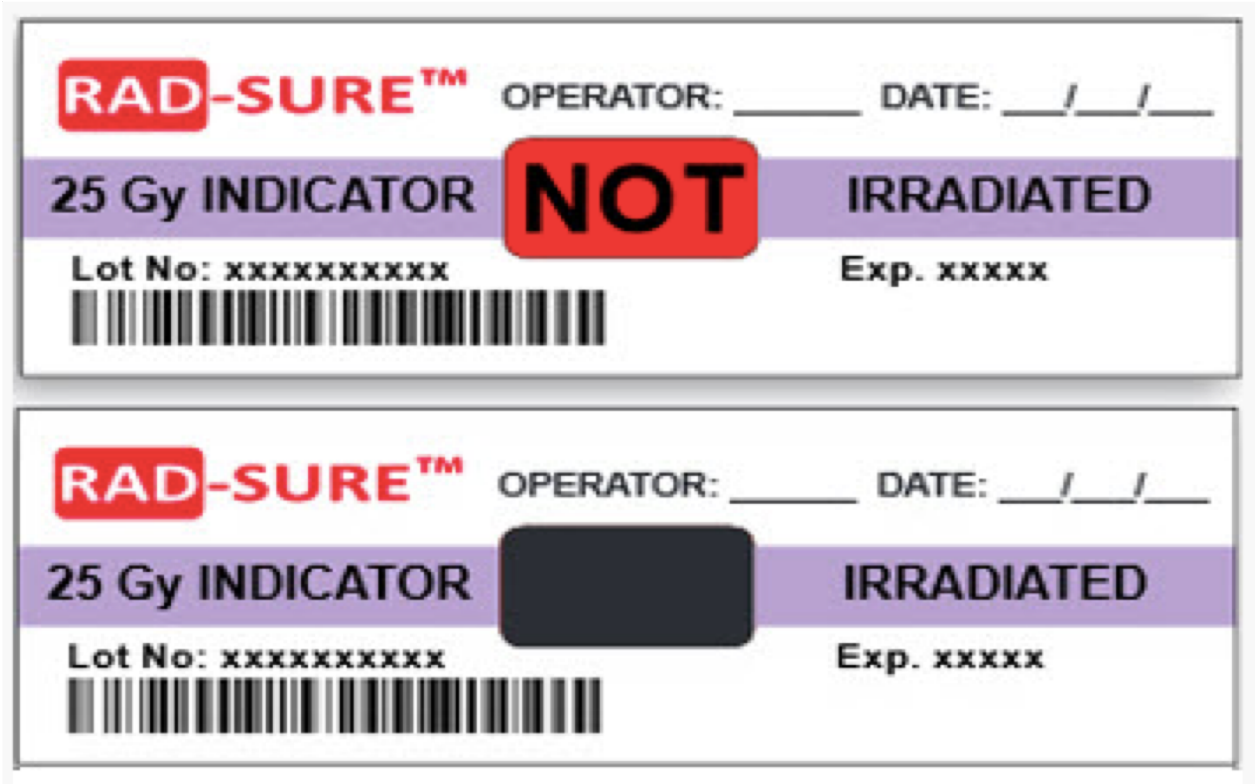
- The patient's immune system may not recognise foreign viable lymphocytes in the transfused blood that then proliferate in the host (patient) usually with fatal results

# Irradiated products

- Lymphocytes are exposed to 25–50 Gy of ionising radiation
- T cells will be non-viable
- Red cells, platelets are not significantly affected
- Blood irradiators are designed specifically for this purpose
  - Using radiation sensitive labels to verify that the process has been successfully completed

# Radiation sensitive label

attached to the blood bag before irradiation



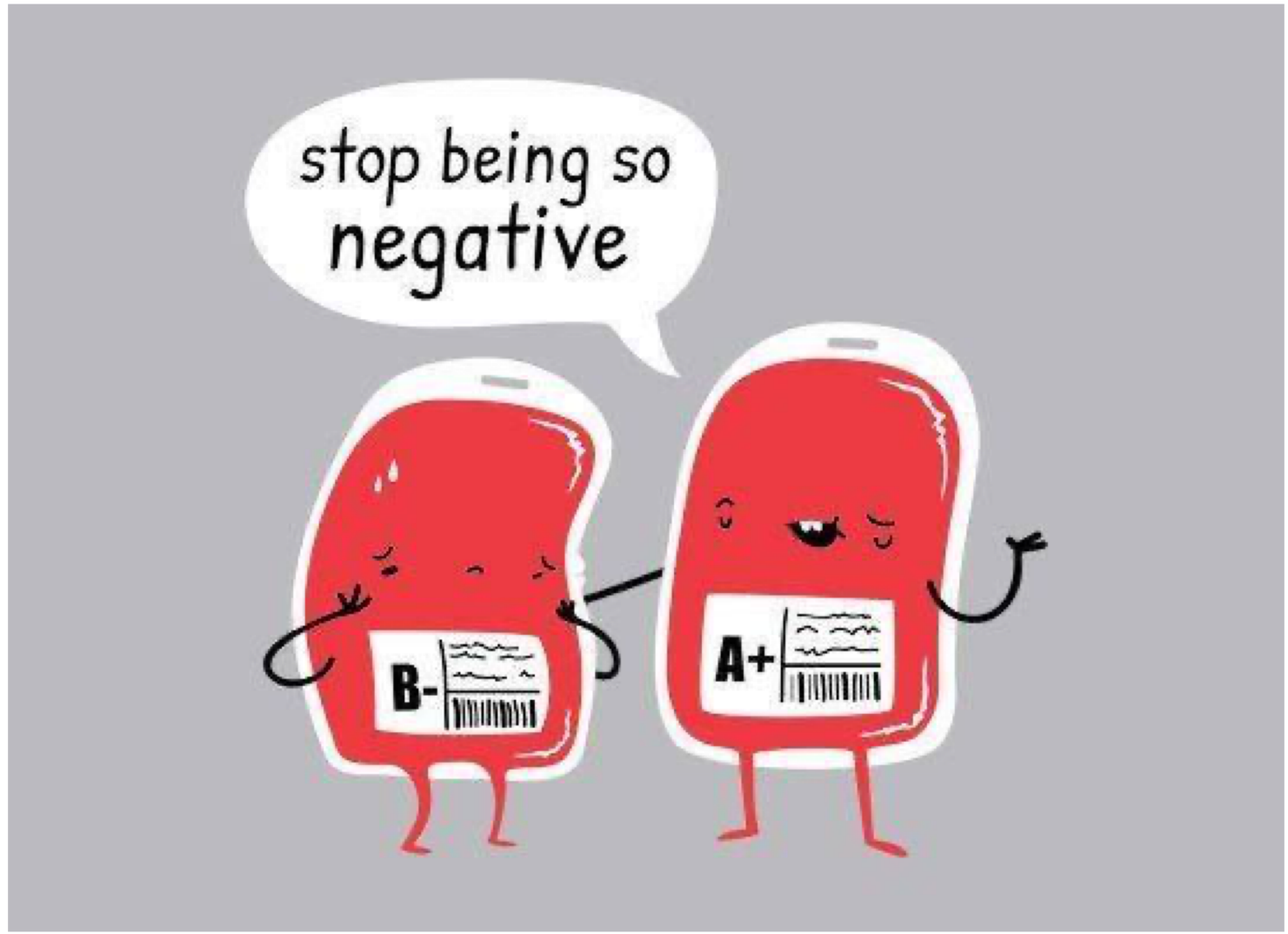

after irradiation the indicator field has turned black, the NOT word has disappeared, the proccess has been success

# Irradiated products

- Red cell products to be irradiated should be less than 14 days old and have a maximum of 28 days shelf life
- Platelet concentrates and FFP can also be irradiated

# Autotransfusion

- Donor and patient is the same
- Before elective surgery (usually orthopedic)
- Maximum collections: 2-3 units
  - The interval between collections is 1 week
- Unused autologous blood is usually discarded and not placed in available stock


stop being so
negative
B-
A+