Contents

Products.....2

Blood Products 2

ABO System 3

Rh System 3

Transfusion Risks 5

Equipment.....7

Cell Saver 7

Procedures 7

Blood Conservation Techniques 7

Surgery on Jehovah Witness 8

Needlesticks & Bodily Fluid Exposure 9

Products

Blood Products

RBC's

- plasma removed (HCT 50-70%)
- additives = citrate, phosphate, dextrose, adenine (CPDA) or SAGM
- volume 200-400mL
- stored at 2-6 deg
- Paeds dose = 4ml/kg
- shelf life 35 days
- needs to be ABO compatible; in emergency use Rh -ve in females
- Max 30 min out of fridge before can return to bb for re-use
- 4hrs to complete transfusion
- May start transfusion after 30min if stored ambiently
- avoid transfusing in line with Hartmans - Ca in fluid will coagulate fluid

Platelets

- pooled (4 donors of whole blood -> centrifuged) or single donor (apheresis)
- kept at 20-26deg with continual agitation in special plastic packs
- shelf life ~5days
- 1 std unit ⟹ ↑count by 20-40
- paeds dose =
    - <15kg 10-20ml/kg
    - >15kg = 1 unit
- ideally ABO compatible, not vital in a crisis
- complete transfusion in 1 hr or return to bb
- bb will only accept back if continually agitated while away from bb
- should use dedicated new giving set

FFP

- centrifugation of whole blood or apheresis
- sourced from males only
- rapidly frozen (within 8hrs post collection)
- UV light viral inactivation
- lasts 1 yr in storgage
- volume = 300mL
- 1 unit ↑all coag factors by ~2-3%
- Paeds dose = 10-20ml/kg
- use in 4hrs
- may return to bb or fridge within 30mins ⟹ kept for 24-48hrs before discarded

Cryoprecipitate

- from single donation apheresis, males only
- rapid thawing @ 4C
- stored at -25 deg
- shelf life 1yr
- rich in factor 2,5,7,9,10, fibringoen, vWB factor, fibronectin
- volume = 20-40mL
- 1 unit ⟹ ↑fibrinogen by 0.5g
- Adult dose = 1unit/30kg
- Paeds dose = 5ml/kg
- should be ABO compatible
- must initiate transfusion within 30mins & complete within 4hrs
- if within 30min then return to bb for safe storage at room temp until it is discarded at 4hrs
- if >30min and not started then should be discarded

- alternative dried concentrated fibrinogen avoids delay in waiting for thawing (common in Europe)

Plasma derivatives
- albumin
- immunoglobulins
- clotting factors
- concentrates

Other products
- artificial O2 carriers (haemoglobin solutions and perfluorocarbons) -> on trial medications
- fVIIa -> see Massive Transfusion Algorithm
- Irritated products ⟹
  - ↓shelf life to 14days
  - use in immune deficient patients and neonates

ABO System

- Antigen – **on rbc cell**
  - ↳ also found in plasma, saliva, gastric juice, tears, bile (not CSF)
  - ↳ unlike Rh which only on rbcs
- Antibodies – **in blood serum**
- Transfusion of packed red cells = transfusion of cells **not** serum
- ABO system named after antigens on rbc cell
- Antigens in intestinal bacteria & food very similar to agglutinins
  - ∴ soon develop antibodies to antigens not already in their own blood

Packed Red Cell Compatibility
- Varieties & frequency (Caucasian) of blood types – named after antigens
  - Recipient A = A antigen; anti B antibody (45%) give A or O
  - Recipient B = B antigen; anti A antibody (10%) give B or O
  - Recipient AB = A & B antigen; no antibody (4%) give anything
  - Recipient O = have no antigens; anti A & B antibodies (43%) give O only
  - ↳ thus O = universal donor; AB = universal recipient

FFP Compatibility
- Recipient O = give anything
- Recipient AB = give AB
- Recipient A = give A,AB
- Recipient B = B, AB
- ∴ universal donor = AB; universal recipient = O
  - ↳ ie opposite to prc's

Rh System

- Named after rhesus monkey
- C, D, E antigens only on rbcs
- D is the most antigenic and most common ~85%
- Rh antibodies =
  - Rarely occur naturally:
    - anti C & anti E

↳ but no natural anti D exists

- Usually
  - Immune created,
  - Warm
  - IgG in origin ie can cross placenta (actively)

- Problem when Rh–ve mother exposed to fetal Rh +ve blood in 1st pregnancy:
  - Needs D antibody (antiD) <72hrs to mop up/destroy Rh D+ antigens which could have corssed placenta/entered maternal circulation
  - this prevents formation of maternal antiD IgG which would cause haemolysis of next pregnancys Rh+fetus (erythroblastosis fetalis)

haemolysis → death in utero, kernicterus, anaemia, jaundice, hyrdops fetails (oedema)
→ bilirubin depositied in basal ganglia

- 85% whites = Rh +ve
- 99% Asians Rh +ve

Safety of Blood Transfusion & Degree of Compatibility testing

Extent tested:	**Relative safety:**
• ABO-compatible	99.4%
• ABO + Rh compatible	99.8% (1:1000 react)
• ABO + Rh + neg antibody screen **aka group & screen**	99.94% (1:10 000)
• ABO + Rh + neg ab screen + Coombs' test ("full X-match")	99.95% (1:500 000)

- Coombs' test adds very little extra and is usually omitted in routine testing.

Transfusion Risks

1. Incorrect Blood Product Transfused

2. Storage Lesions

- ↓pH:
  - due to: lactic acid production from rbcs AND citrate
  - pH blood 6.9-7 @21days
  - but uncommon & usually only in massive transfusions
  - more common is slight met alkalosis: citrate metabolised to HCO3
- ↓2,3DPG:
  - L shift OHDC
  - usually not impt
- ↑K:
  - blood @21days = 30mmol/L
  - usually not an issue
  - give Ca if needed
- ↓Ca:
  - citrate toxicity
  - not problem unless >1unit/5min
  - risk factors:
    - liver dysfunction
    - hypothermia
    - hyperventilation
- ↓Mg

3. TRALI

- 2 theories of cause:
  - donor anti-granulcytic antibodies in plasma react with recipient WBC antigens ⟹ immune reaction
  - biologically activated mediators and lung mediate reaction
- acute respiratory distress within 6 hours of transfusion
- supportive care and inform blood bank
- incidence = 1:5,000 U of plasma containing products (FFP, platelets or whole blood)

Diagnosis:
- acute onset ALI (with in 6 hours of a transfusion)
- hypoxia (PaO_2/FiO_2 = 300mmHg regardless of PEEP or SpO_2 <90% of RA)
- bilateral pulmonary infiltrates
- not cardiogenic in origin
- PAWP < 18mmHg

Pathophysiology:
- complement activation -> pulmonary sequestration -> neutrophil activation -> endothelial cell damage + capillary leak syndrome

Management:
- stop transfusion
- supportive
- respiratory support (most require intubation)
- lung protective ventilation
- haemodynamic support
- ? high dose steroids
- inform blood bank and haematology

Prognosis:
- most recover within 48-86 hours

- radiological changes last 7 days
- mortality 10%

Prevention
- leucodepletion & use of male only donors of blood products now means TRALi v rare
- limit transfusion of blood products
- preoperative optimization of blood volume (dietary supplements, Fe2+, EPO)
- prevent hypothermia
- use anti-fibrinolytics
- cell salvage
- avoid donations from multiparous women

4. Acute Transfusion Reactions

- allergic:
  - incomptatible plasma proteins
  - mild (rash, pruritis, fever):
    - = common
    - slow infusion
  - mod:
    - stop, give antihistamines
  - severe:
    - anaphylaxis
    - IgA to IgA deficient patient who has anti-IgA antibodies
- febrile
  - non haemolytic type
  - occurs <4hrs
  - cause =
    - recipient antibodies against donor WBCs
    - cytokines in donor product
  - Rx:
    - slow
    - give tramadol for shivering
    - stop
- haemolytic - ABO incompatible

5. Delayed Haemolytic Transfusion Reactions

- antibodies against minor donor rbc antigens
- 10-14days post
- signs: ↓Hb, ↑bili, ↑LDH, agitation, fever, rash, shock
- Supportive care
- Notify bb

6. Transfusion-transmitted infections

- HIV - 1% risk at needlestick (but no known ANZ transmissions)
- hepatitis A
- Hepatitis B - 30% risk at needlestick
- Hepatitis C - 3% risk at needlestick
- syphilis
- CMV - leucodeplete
- malaria
- CJD (leucocyte depleted to decreased risk of CJD transmission)
- bacterial

7. Transfusion Associated Cardiac Overload

Equipment

Cell Saver

= collection of a patients blood loss, anticoagulation, filtration -> reinfusion into patient
- Indications
  - ≥1litre blood loss expected incl trauma
  - High risk surgery
  - unusual blood type/antibodies
  - JW
- two types of devices available (haemofiltration and washing of RBCs)

Advantages

- homologous blood transfusion
- decreased risk of disease transmission
- blood warmer than stored blood
- cost effective after a period of time as less resource required in preparation and storage of donor blood
- washing RBC's technique -> removal of platelets and clotting factors
- whole blood transfusion rather than component blood products (haemofiltration technique)
- may be acceptable to some Jehovah's Witness patients
- no need to cross match
- efficient
- decreased risk of storage lesion
- quick

Disadvantages

- all of blood loss not able to be reinfused
- expensive equipment initially
- requires trained personnel to manage salvage system (may not be always available)
- blood anti-coagulated -> increased risk of bleeding
- may not be set up and available for unexpected massive blood loss
- dilutional coagulopathy
- contraindications = Gi tract contamination, amniotic fluid contamination, malignancy
- haemolysis

Procedures

Blood Conservation Techniques

Preoperative Management

- optimise preoperative Hb if <130 : iron +/- EPO
  - investigated and treat cause of anaemia - iron studies & haematinincs
  - stop anti-platelet and anti-coagulation
- Therapy:
  - oral iron/IV iron
  - EPO (max effect after 4 weeks)
  - autologous donation (see notes)

Intraoperative Management

SURGICAL
- less invasive surgery
- LA with vasoconstriction
- fibrin glue
- tourniquets

- ultrasonic scalpels
- laser

ANAESTHESIA
- avoid venous congestion (patient positioning, high intrathoracic pressure, hypercapnia)
- epidural + spinal -> reduces both venous and arterial pressures
- keep warm
- induced hypotension
- anti-fibrinolytics; transexamic acid
- rFVIIa
- increased platelet function; DDAVP
- acute normovolaemic haemodilution
- intraoperative cell salvage

Postoperative Management
- post-operative cell salvage
- Restrictive transfusion threshold

Surgery on Jehovah Witness
- should discuss with patient what they accept:

Unacceptable; whole blood, PRBC's, plasma, autologous pre-donation
Acceptable; bypass, dialysis, acute hypervolaemic haemodilution, EPO, rVIIa
May be Acceptable; platelets, clotting factors, albumin, immunoglobulins, epidural blood patch, cell salvage

Preoperative Management
- elective; talk and go through options and advance directives
- emergency:
  - seek patients wishes, but if unable to get OK to act in best interests,
- children (<16yrs) =
  - parents can't refuse on child's behalf
  - can involve courts if required
  - must try to establish wishes of child ?competent
- early communication essential
- assess what is and is not acceptable to patient
- involve relevant specialities (haematology, ICU)
- liaise with local JW liaison
- investigate and treat any anaemia:
  - Fe2+ (PO/IV)
  - EPO
- review anti-platelet and anticoagulants
- discuss whether surgery can be staged to decreased acute blood loss

Intraoperative Management
- meticulous surgical technique
- argon beam diathermy
- biological haemostasis (haemostat, kaltostat, fibrin glue, sealants)
- reduce venous congestion (patient positioning, avoid high intrathoracic pressures, hypercarbia)
- warm
- invasive monitoring
- regional if appropriate
- hypotensive anaesthesia
- drugs; tranexamic acid, DDAVP
- acute hypervolamic haemodilution (administer IVF to increase volume but don't remove blood)
- cell salvage (if acceptable)

- rVIIa

Postoperative Management

- ICU if required
- direct compression of oozing
- early re-exploration
- hyperbaric O2 may reverse severe hypoxaemia

Needlesticks & Bodily Fluid Exposure

Standard Universal precautions should be used with every patient as any one may carry infectious either knowingly or unknowingly.

1. Vaccination against Hepatitis B
2. Gloves – double gloving provides extra protection
3. Blunt needles where practical
4. Sharps containers (accessible and changed frequently once full)
5. Those who use sharps should take responsibility for discarding them safely
6. Safety IV cannulae
7. Adequate cleaning and sterilisation of spilt blood products
8. Good communication when a patient is known to be high risk is coming to OT (experienced staff to perform invasive procedures)
9. Not reusing vials or needles between patients
10. Having adequate suction available to remove blood and other body fluid.
11. Strategy/Protocol for a potential contamination injury:
    - first aid:
        - encourage bleeding of area
        - apply alcohol gel to area
        - flush area with running water for 10 min
        - dressing area
    - follow up:
        - notifying hospital co-ordinator,
        - filling out incident form,
        - consent to sample patients blood for viral agents
        - if known high risk patient - empirical treatment to healthcare worker
            - rapid Hep B booster
            - other immunisations
            - anti-retrovirals
        - taking of health care worker baseline blood
        - immediate processing with occupational health follow up,
        - strategies to prevent his happening again.