Blood components

Whole blood is collected from a donor animal for blood transfusion purposes into a blood bag containing citrate phosphate dextrose as the anticoagulant. Donor animals should be selected with care and strict attention should be paid to the blood collection technique to maintain sterility at all times. Once the blood has been collected, it can be kept and used in its natural state or can be converted into a variety of components. These blood components are packed red blood cells, platelet-rich plasma, platelet concentrates, fresh plasma, fresh frozen plasma, frozen plasma, cryoprecipitate and cryosupernant. Double, triple and quadruple blood bags (a single whole blood collection bag with various satellite bags) are used for producing and separating components within a sterile closed environment. Blood component production is highly desirable for several reasons, including maximization of the yield of products from a single blood donation and ability to use the optimal products (in high concentrations) for specific diseases (thus minimizing the amount of unnecessary foreign material the recipient animal is exposed to). The most commonly available blood components are whole blood, packed red blood cells, fresh frozen plasma and cryoprecipitate.

Some definitions may be useful for understanding blood components:

**Whole blood:** This is blood collected directly from a donor animal into a blood transfusion bag containing citrate-phosphate-dextrose with (CPDA-1) or without adenine (CPD) as an anticoagulant. In general, for dogs, a 500 ml transfusion bag is used (which contains approximately 63 ml of anticoagulant, obtaining approximately 450 ml blood from the donor dog). Whole blood can be used immediately or stored at 4 C for future transfusion or separation into blood components. Additives can be used to improve red cell storage viability (see below).

**Packed red blood cells:** These are a concentrated source of red blood cells that remain in a small amount of plasma upon removal of supernatant plasma after centrifugation of the blood transfusion bag containing whole blood. Packed cells are an excellent source of red blood cells for anemic animals that need the additional oxygen-carrying capacity these cells provide. Packed red cells can be used immediately or stored at 4 C. They need dilution in sterile isotonic solution prior to infusion (due to the high hematocrit, packed cells without dilution are very thick and flow sluggishly through infusion lines). The current standard for red cell storage is that there should be about 75% posttransfusion viability after storage, that is at least 75% of the transfused red cells must remain in the recipient's circulation 24 hours after transfusion. The posttransfusion viability of canine red cells collected into CPDA-1 is 20 days.

Additives have been developed that can be added in a sterile fashion
(they are attached to the original transfusion bag as a satellite bag) to packed red cells (or whole blood bags) to optimize red cell storage viability. These additives usually contain dextrose and adenine for red cell energy metabolism and mannitol, which decreases red cell lysis. Several additives have been evaluated with canine red blood cells. Both Nutricel and Adsol increase the posttransfusion viability of stored canine red cells to 35 and 37 days, respectively.

**Platelet-rich plasma (PRP):** Platelet-rich plasma is produced by separating plasma from red blood cells (within 6 hours of whole blood collection) using a slow spin to prevent pelleting of the platelets. Platelet-rich plasma is useful for the treatment of disorders of platelet number and function but must be infused within 8 to 12 hours (maintained at room temperature) due to platelet instability (which limits its use).

**Platelet concentrates:** Platelet concentrates are produced by separating most of the plasma from platelet-rich plasma. Platelet concentrates are used similarly to platelet-rich plasma.

**Platelet-poor plasma (PPP):** Platelet-poor plasma is produced by separating plasma from red blood cells using a high spin to pellet platelets with the red cells. This is the starting point for production of most blood components. Separation of platelets is desirable because they provide an additional source of foreign antigens and micro-aggregation can cause transfusion reactions. Approximately 200 to 400 ml of plasma are obtained from each whole blood transfusion bag. **One unit** of plasma is defined as that obtained from a single whole blood transfusion bag.

**Fresh plasma:** This is platelet-poor plasma that is separated from red cells and infused **within 6 hours** of blood collection (with the blood bag being maintained at 4 C until separation).

**Fresh frozen plasma (FFP):** This is platelet-poor plasma that is separated from red cells **within 6 hours** of blood collection and frozen in a dedicated freezer (at or below -20 C). Fresh frozen plasma and fresh plasma contain all coagulation factors and plasma proteins (such as albumin). Fresh frozen plasma is stable for 1 year if maintained in a dedicated freezer (one that does not undergo freeze-thaw cycles like household freezers) at or below -20 C. **One unit** of FFP is defined as that obtained from a single whole blood transfusion bag (approximately 250 ml).

**Cryoprecipitate (CPP):** Cryoprecipitate is a concentrated source of von Willebrand factor, fibrinogen, factor VIII and fibronectin. It is produced by slow-thawing (at 4 C) fresh frozen plasma, followed by centrifugation at 4 C. Cryoprecipitable proteins (those
mentioned above) precipitate at this temperature and are maintained in a very small amount of remaining plasma (approximately 1/10 of the starting volume of FFP, or about 20 to 30 ml). Cryoprecipitate is stable for 1 year from the date of collection of the whole blood for transfusion purposes (not the date of preparation of the product) if maintained at or below -20 °C in a dedicated freezer. **One unit** of cryoprecipitate is defined as that obtained from a single FFP bag (approximately 250 mL plasma).

**Cryosupernant (Cryosuper):** Cryosupernant is the remaining plasma after removal of the pelleted cryoprecipitate. This is a source of all coagulation and plasma proteins, except for factor VIII, fibrinogen, von Willebrand factor and fibronectin. Cryosupernant is stable for 5 years if stored in a dedicated freezer at or below -20 °C.

**Frozen plasma:** Frozen plasma has several sources. It can be plasma that is separated and frozen longer than 6 hours after whole blood collection. It can be fresh plasma that is not used within 6 hours of collection and then frozen. It can be fresh frozen plasma maintained for longer than 1 year in a dedicated freezer. Frozen plasma lacks certain coagulation factors which are quite unstable, including factor VIII, von Willebrand factor and factor V.

A **schematic illustration** of how these major blood component products are produced may be helpful.
Definitions: PRBC: Packed red blood cells; PRP: Platelet-rich plasma; FFP: Fresh frozen plasma; Cryosuper: Cryosupernatant; CryoPP: Cryoprecipitate.