PLASMA TRANSFUSION

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Plasma is blood minus the cellular elements, and must be distinguished from serum, in which the blood has been allowed to clot, thus removing fibrin as well as the cells. The plasma is produced by mixing the blood with an anti-coagulant, such as 3.8 per cent. sodium citrate solution (one part to nine parts of blood), and then allowing the red cells to settle to the bottom of the container. The white cells settle as a pale layer just above the red cells. This sedimentation is normally complete in about four days, and is allowed to take place undisturbed in a refrigerator. The supernatant yellow fluid is the plasma, and this is drawn off under aseptic conditions into a separate sterile bottle. The plasma is often quite milky in appearance, due to fat globules being suspended in it, but this merely indicates that the donor has had a meal recently, the fat at this stage being carried round in the blood on its way to the fat depots. One pint of citrated blood usually yields about 300 c.c. of plasma.

The plasma contains a large number of inorganic and organic compounds, which exist in carefully balanced proportions, but the most important constituent from the transfusion point of view is the plasma proteins. These consist of albumen, globulin and fibrinogen, and in all are present to the amount of 6.5 to 8.0 gms. per 100 c.c These proteins are the important factors which keep the blood in the capillaries, as, without these, the capillary walls, being of semi-permeable membrane, would allow all the fluid part of the blood to escape into the tissues, and leave behind a conglomerate mass of red cells. These protein bodies produce a force—termed the osmotic pressure—which causes a continuous flow of fluid back from the tissue spaces into the blood stream. Thus it is seen how important it is that the plasma protein level be kept up, for, if it falls, then less fluid is drawn back from the tissues than enters them, and the condition of œdema is eventually set up.

The pathological states in which there is a fall of plasma protein are as follows:

Shock and haemorrhage. Here the capillary walls, owing to changes in their structure induced by a lack of oxygen, allow the passage of plasma proteins from the blood stream into the tissues. These escaped proteins draw still more fluid out of the blood vessels, leaving the red cells in a highly concentrated state, and the blood may become so viscous that it hardly flows at all. The total blood volume in the body, which normally amounts to about six litres (10½ pints), is thus reduced and the circulation is slowed. To restore the normal state, fluid must be added to the blood stream, but at the same time proteins must be given with it to make it stay in the vessels, and here the administration of plasma

is of importance. Shock is associated in very many cases with bleeding, but in a single acute hæmorrhage it is rare for more than 1,500 c.c. of blood to be lost, and, as the total blood volume is 6,000 c.c., it will be seen that there is still about seventy-five per cent. of the red blood cells left. But they have become concentrated in the capillaries and they need plasma to allow them to circulate again. Nevertheless, in cases of repeated hæmorrhages, such as hæmatemesis, the number of red cells may fall to a very low level, and such cases are in need of whole blood transfusion.

Burns. Here there is the combination of shock and loss of plasma, but practically no bleeding. The plasma is exuded into the burnt area and forms the characteristic vesicles and "weeping surface." The red cells in the blood become concentrated, due to the loss of this fluid, and the administration of plasma is indicated in such cases.

Œdema. In certain types of kidney disease, *e.g.*, lipoid nephrosis, there is a continuous loss of protein from the blood stream through the damaged kidneys, giving the heavy albuminuria. This eventually lowers the amount of protein in the blood, and, as explained above, the osmotic pressure falls, allowing œdema to occur. In such a condition, the administration of plasma allows a temporary improvement to occur.

Too much intravenous saline. This produces a dilution of the constituents of the blood plasma, lowering the plasma protein level, and at the same time increasing the salt content of the tissues. This increasing salt content will draw fluid from the blood stream into the tissues, but, as the already lowered plasma protein value is unable to counteract this, œdema of the tissues results. One of the most serious manifestations of this is acute œdema of the lungs, which may be rapidly fatal, unless protein is given in the form of plasma to reconstitute the normal values. This point emphasises once again the great care that must be used with the administration of saline, either rectally or intravenously. Two pints per day is nearly always ample (except in cases of severe vomiting or diarrhœa), and any other fluid, apart from that given by mouth, should be given as five per cent. glucose in *distilled water* (intravenously) or tap water (per rectum).

Plasma is drawn off from the blood. When the red and white cells have settled it may be stored in a refrigerator in sealed bottles as normal plasma, or it may be mixed with an equal quantity of normal saline—the resulting fluid being called "plasmal saline." The plasma may be dried by evaporating off all the water in a vacuum, and this leaves a yellow powder which may be redissolved in distilled water when needed. 20 gms. dissolved in 250 c.c. of distilled water reconstitutes 250 c.c. of normal plasma. The dried product facilitates transport and it may be stored at normal temperatures.

The plasma is given to the recipient exactly like a blood transfusion. It must be filtered before administration, as during storage small flakes of fibrin tend to separate out. It should be given slowly, at about half the normal rate for blood, to prevent any untoward reactions. Typing of the blood group of the patient is unnecessary, and plasma of any group may be given to any recipient as long as not more than 500 c.c. is given at once. This is because the agglutination factors in the administered plasma are so diluted by the recipient's own plasma that they are virtually ineffective if the dose is kept below the limit indicated above. This dose should be effective in practically every case. Group I. plasma has the advantage that it has no agglutination factors in it, and thus may be used in unlimited quantities, but suffers from the disadvantage that only three per cent. of the population come under this group, and hence supplies of this group plasma are not so easy to obtain. Plasma will keep in good condition for some months, compared to the fourteen to twenty-one days of blood, and for this reason is very valuable as an emergency supply.

In conclusion it may be stated that plasma transfusion is indicated in certain definite states only, described above, and must not in any way be considered a substitute for all blood transfusion.

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PREPARING PLASMA FOR TRANSFUSION

The disadvantage about a blood bank is that the stored blood will not keep for any long period of time. After a certain period has elapsed the blood cannot be used for transfusion purposes without filter treatment, so there must be a continual renewal of the store in the bank in order that any emergency may be met.

For most purposes plasma can be used for transfusions instead of blood, and it has the added and very important advantage that it will remain usable for a much longer period. The following are the life periods of bottled boood, fluid plasma and dried plasma:

Bottled blood. 21 days for emergency use; 14 days is the limit for deliberate use.

Fluid plasma. The life period is not known for certain, but it is probably indefinite, especially if the plasma is kept in a refrigerator and bacteriologically sterile.

Dried plasma or serum. The life period is almost certainly indefinite under all climatic conditions if kept in original sealed and sterile containers.

The production of plasma from blood under ordinary conditions is a long process, taking about four days, but the Army Blood Transfusion Service has now perfected a method which allows of 300 to 400 pints of blood being dealt with each day as a normal routine. It is on record that an emergency demand for nearly 500 pints of plasma was met within 24 hours.