

## BLOOD TRANSFUSION

For purposes of this manual it is sufficient to say that blood transfusions are given to increase blood volume, red blood cells, blood protein, blood coagulating elements, or some of the less well understood portions of the blood such as its immunologic properties. Hemorrhage heads the list of the clinical indications for blood transfusion. Other indications in the order of their relative importance are: shock, hypoproteinemia, Hypothrombinemia, thrombocytopenia, the various blood dyscrasias, and infections.

### METHODS.

Direct or unmodified blood transfusions probably will find no place in our hospital. The indirect modified blood transfusion most popular in this country at the present time is the citrate method. After preliminary typing and cross matching, the donor has a serological test performed. If the Kahn or Wassermann test is negative and the prospective donor has no history of allergy or malaria he is briefly examined for acute infections by inspecting the nose and throat and taking his temperature. A hemoglobin test must show that he has 80% hemoglobin or higher. The donor must always lie down while blood is being taken. After taking blood he should lie down for 15-20 minutes and be given at least a glass of some liquid. He is then permitted to go about his business without restriction. The arm is washed with soap and water for 10 minutes (if not available alcohol on the skin may be substituted). The donor is then told to lie on a cot or operating table and a blood pressure cuff inflated to 50 - 60 mm Hg. applied to the arm chosen as the donor site. A large vein is then punctured with a 12 to 16 gauge needle. The needle is connected with a sterile flask containing a sufficient quantity of sodium citrate solution to prevent coagulation (50 cc 2.5% solution per 500 cc of blood). The flask is gently rotated while collecting the blood so as to thoroughly mix the blood and citrate solution. Then the flask is arranged so as to inject the blood citrate mixture into a vein of the recipient at the rate of 500 cc per half hour. This rate may be speeded up if the need for blood is more acute than is commonly the case. The quantity of blood to be given is the quantity needed and no hesitancy should be felt in giving as much as five or more liters if this quantity is required. The blood should not be warmed while it is being administered, great harm can be done by over heating the red blood cells and the safest rule is to apply no external heat. No reason should occur for giving a direct or unmodified blood transfusion since such an emergency can be handled by first giving either crystalloids or blood plasma while the blood is being collected and made ready for administration.

### CARE OF APPARATUS.

All apparatus must be clean and must be rinsed thoroughly in freshly distilled water before sterilization. No tap water or old distilled water should be allowed to touch the apparatus at any time. Before original use all rubber connections, tubing, stoppers, as well as all glassware must be boiled in

0.5% sodium hydroxide solution for 20 minutes. The apparatus is then carefully washed by use of repeated lavage with freshly distilled water. After use, the prompt rinsing of the apparatus with freshly distilled water (before the blood is allowed to dry on the tubing) readily frees the apparatus of all old blood. Any particles left on the tubing or glassware should be brushed or washed away, using soap and water if necessary. Thorough rinsing with fresh distilled water must then be repeated before sterilization. The flasks are usually sterilized in cloth bags and all apparatus thus kept together in one parcel so that an emergency transfusion may be done with the minimum of confusion.

#### ADMINISTRATION.

It is essential that a nurse or ward man be within easy calling distance of a recipient of a blood transfusion at all times, preferably by his side. The flow of blood may be interrupted, the patient may have a reaction from the transfusion, or the patient may become alarmed. The procedure must be minimized to the patient and his fears allayed by reassuring him as to his likelihood of recovery and such. Should any sign of a reaction occur the flow of blood must be cut off immediately and the ward officer summoned.

#### REACTIONS.

Hemolytic. The most serious reaction is called a hemolytic reaction and consists of a number of symptoms all or any of which may or may not be present. The patient may complain of a severe chest pain, pain in the back, feeling of weakness, he may faint, he is usually very anxious and may complain of inability to get his breath and vomiting may occur. Immediately it will be noted that his pulse rate and respiratory rate have increased, his blood pressure has fallen and he may be very white or cyanotic and covered with perspiration. Soon afterwards the patient has a chill followed by a rapid rise in temperature. This reaction is usually due to incompatible blood and in most cases is due to administration of the wrong type of blood. The patient then either promptly recovers or develops an anuria which may be terminated in a few days by death. On the other hand the patient may at any time up to two weeks develop a diuresis and recover. Treatment is directed toward the relief of the anuria and is otherwise symptomatic. The immediate transfusion of compatible blood is usually indicated. The alkalization of the patient has been advocated both before and after transfusions but has not been shown clinically to be of benefit. These reactions are rare, fortunately, but are associated with a mortality of approximately fifty percent.

Febrile. The more common febrile reactions consist of a chill and fever which subside promptly without any other signs of trouble. These are due to so-called pyrogens, bacterial toxins produced by bacteria found in open bodies of water, which have not been removed from the apparatus or solutions before use. These reactions can be practically eliminated by the use of freshly distilled water in the cleansing of the equipment and preparation of solutions.

Allergic. The allergic reactions which are usually not severe consist for the most part in urticaria of varying degrees of severity. They usually yield to adrenalin but may persist for a day or so following the transfusion. Passive transfer of allergy has been shown to occur with transfusions.

Transmission of Disease. The transmission of disease by means of blood transfusions is now a matter of common knowledge. The most serious of diseases so transmitted is syphilis. The donor is usually in the secondary stage and if careful serology always precedes the transfusion the danger is eliminated for all practical purposes. Malaria may be so transmitted also and can be eliminated only on the basis of a history in the donor of chills and fever at any time in his life previously. On this basis one authority states that he has had no case of such transmission in over 5000 cases. Other diseases may be transmitted but are so rare that if the donor is not acutely ill there is probably no danger.

Pulmonary Edema. Occasionally during the course of a transfusion the patient becomes very dyspneic and begins to cough. This usually occurs in the older patients who have some heart disease. The symptoms mentioned mean the development of an acute pulmonary edema. The transfusion should be stopped immediately and oxygen if necessary. This reaction can usually be prevented in such patients by the very slow administration of blood, 500 cc being given over a four or six hour period.

Blood Dyscrasias. For some reason, not clear to us at present, patients with blood dyscrasias tend to have reactions more commonly than do others. This may be due to sensitization to blood since most of such cases have been repeatedly transfused before the appearance of these reactions becomes troublesome.

#### BLOOD SUBSTITUTES.

Many substances have been tried with the idea of replacing blood. The most satisfactory of such substances yet found are blood plasma, blood serum, lymph plasma, lymph serum, and solutions of essential amino acids. Other protein solutions which have been tried are yet too undeveloped to permit of evaluation.

Blood plasma is simply the liquid portion of blood separated from the blood cells by sedimentation or centrifuging the blood, usually citrated. This solution has some foreign substance such as sodium citrate in it but in other respects is the same as normal blood plasma. It may be stored for considerable periods of time but requires straining before administration. When pooled with other types of plasma the mixture may be given freely to patients without the necessity of typing or cross matching.

Blood serum is the liquid portion of the blood remaining after clotting and retraction of the blood clot. Thus it contains the same substances as plasma except for the fibrin which is contained in the clot. In general it may be said that its uses are similar to those of plasma and that if pooled typing is unnecessary. Serum has one advantage over plasma in that no fibrin precipitate forms and thus filtration after a long period of storage is unnecessary.

The uses of blood plasma and serum may be briefly mentioned: the emergency treatment of hemorrhage, the definitive treatment of shock, burns, and protein deficits. It must be remembered in giving these substances that plasma has less protein per cubic centimeter than serum because of the addition of sodium citrate solution in the preparation of plasma. These blood

substitutes serve to keep fluid in the vascular spaces much more efficiently than crystalloids or other solutions given to tide the patient over until whole blood can be administered. It is believed that except in cases of protein deficits without anemia these substances should be considered as substitutes since they are probably inferior to whole blood transfusions. This may not apply in those cases of shock or burn shock where the hematocrit is very high and one wishes to dilute as well as enlarge the circulating blood volume.

Blood plasma or blood serum have been evaporated at a low temperature to obtain what is known as lyophile serum or plasma. These dry powders are complete with all the substances present in the parent substance, apparently intact. They may be dissolved in water to form new solutions (similar to the original) and used in place of plasma or serum. They may be dissolved in a smaller quantity of water and serve to dehydrate the patient as in cases of edema or head injuries. Due to the difficulty in evaporation these materials will be less readily available than will the whole serum or plasma.

#### PROTEIN SOLUTIONS.

The development of human albumin from animal sources, the protein free solutions of pectin and other solutions of similar nature have not yet proceeded far enough to be of practical value although the first mentioned gives promise of being of material aid in the future.

The solutions of amino acids now available are not quite adequate for complete protein replacement but are of considerable assistance in supplying protein to patients with severe deficit.

Gum acacia and other such viscous solutions are now definitely on the decline and probably will be completely discarded. Reports of red blood cell and liver damage from the use of acacia have caused many physicians to discontinue their use. In any event gum acacia is inferior to blood plasma or serum.

#### STORED BLOOD.

Under some conditions, principally when donors are not readily available, it is desirable to obtain blood at convenient times and store it in a refrigerator so that it will be ready for use when needed in large quantities. In general it is believed that one of the blood substitutes will serve this purpose and will not have the disadvantage of deterioration in storage.

Storage is a relatively simple matter. One simply draws blood into a citrate solution as for a citrate blood transfusion and usually an equal quantity of 5% glucose is added. This mixture may then be placed in a refrigerator at from 0 to 4° C and kept as long as ten days without severe deterioration. There is some loss of red blood cells by this time and all the white cells, platelets and prothrombin have been destroyed. Such blood is adequate for the replacement of circulating volume and to replace lost red blood cells. It is of little value otherwise. Even in these conditions it is inferior to fresh blood, giving a much higher reaction rate and producing a less marked favorable response.