# BLOOD TRANSFUSION

## A GUIDE TO THE PRACTICE OF TRANSFUSION WITHIN HOSPITALS

by

**GEORGE DISCOMBE**

M.D., B.Sc.(Lond.)

Pathologist, Central Middlesex Hospital

6s. net

WILLIAM HEINEMANN · MEDICAL BOOKS · LTD

# BLOOD TRANSFUSION

## A GUIDE TO THE PRACTICE OF TRANSFUSION WITHIN HOSPITALS



by

**GEORGE DISCOMBE**

M.D., B.Sc.(Lond.)

Pathologist, Central Middlesex Hospital

LONDON

WILLIAM HEINEMANN · MEDICAL BOOKS · LTD

1955

FIRST PUBLISHED 1955



PRINTED IN GREAT BRITAIN BY THE WHITEFRIARS PRESS LTD.
LONDON AND TONBRIDGE

# FOREWORD

THIS pamphlet is intended as a guide to the practice of transfusion within hospitals. It is written primarily for the temporarily registered doctor doing his first resident appointment. It stresses the difficulties and possible dangers he has to avoid. No more of the theory or technique of transfusion is described therefore than is necessary to aid his clinical judgment. When he has read and digested it he will then be in a position also to appreciate the standpoint of the laboratory worker. This will lead to a mutual understanding which should greatly facilitate the smooth working of the transfusion department with which he has to deal.

Finally, in addition to the audience for which it is primarily intended it is hoped it may interest members of a wider medical circle.

G. D.

*September*, 1955.

# CONTENTS

# BLOOD TRANSFUSION

## CHAPTER I

## THE DEVELOPMENT OF TRANSFUSION

ALTHOUGH blood transfusion was widely used before 1939 it was usually reserved for patients who were very ill and might be expected to die without it. Even as late as 1940 the author was expected to anæsthetize patients whose hæmoglobin might be less than 6 grams per 100 ml. (40 per cent.), and blood for transfusion could be obtained only after a delay of several hours.

The revolution in the general attitude to blood transfusion started in 1939 in London, and a few months later in Bristol and other large provincial centres. It was due to the introduction of stored blood, collected with, stored in, and administered by apparatus of simple design which was standardized throughout the country and the armed forces. The alterations since 1939 have been changes in detail; the old Record needle mount has been superseded by the larger Luer, the slim-waisted bottle is being changed for a straight-sided one which rejoices in a British Standard Specification (No. 2463), while the rubber washer secured by a screw-on aluminium cap has been replaced by a rubber plug through which needles are thrust when collecting or giving blood, thus avoiding the necessity for removing the aluminium cap and rubber washer to insert a rubber bung when collecting blood. All these are small changes, and some are improvements.

Before 1940 the Rhesus factor was unknown : occasionally unexplained deaths followed transfusion, but as transfusions were given only to patients who would pro-

bably otherwise have died, an occasional death was a reasonable price to pay for the benefits conferred on the majority of recipients. When it was found that the Rhesus factor, and the antibodies to it, were the principal cause of intra-group hæmolytic transfusion reactions, many came to believe that transfusion had been made completely safe. This belief is false, for there are a number of blood group antigens which can be responsible for fatal transfusion accidents ; and sometimes reactions with no discoverable cause may also occur, a few sufficiently severe to kill the patient.

This belief that blood transfusion is a perfectly safe procedure has been accepted by many of the general public, and lawyers have claimed that the doctrine of *res ipsa loquitur* should apply to all cases of fatal transfusion accidents. The phrase *res ipsa loquitur*, " the thing speaks for itself," is a clear exposition of the doctrine—it is claimed that blood transfusion is so safe that any fatal consequence is such strong evidence of negligence that the defendant—that is, the giver of the fatal transfusion—has the duty of demonstrating that he was not negligent, while the plaintiff in order to substantiate a claim for damages, need bring no evidence beyond the fact of death following transfusion.

This doctrine has its classical illustration in the case where a pedestrian was walking in the street when a barrel fell from the first floor of a building and injured him ; the occupiers of the building had a duty to avoid injuring foot-passengers, and barrels do not fall from buildings unless their movement is started by some human agency—in this case, presumably, an employee or licensee of the occupiers. It has been applied in surgery ; a patient sought relief from a Dupytren's contracture, and left hospital with a useless claw-hand in which four fingers were immobile. In the special case of blood transfusion,

however, Mr. Justice Hilbery (1953) has refused to apply this dictum, and should any future attempt to invoke it be made, there are a number of cases on record in which very severe hæmolytic transfusion reactions, three of them fatal, followed the administration of blood which was both compatible and sterile as far as could be ascertained by the most modern techniques (Discombe 1952 ; Shackle 1953, Cannon 1953, Pinkerton 1953 ; Stephen, Martin and Bourgeois-Gavardin 1955).

The duty of a hospital and its officers is to exercise reasonable care in the selection, distribution and administration of blood. The term " reasonable care " cannot be closely defined, for it involves that mythical being, a " reasonable man." Perhaps the best way of defining reasonable care is to assess first of all the frequency with which that complication which might be guarded against is likely to occur. If it is likely to occur *once in 100* or even *once in 1,000* events, then it must be guarded against, especially if the frequency of unpredictable complications is much lower ; at a frequency of *1 in 10,000* the need for special care would be less, especially in emergency, unless this particular complication was usually fatal and easily avoided ; but at or below a frequency of *1 in 100,000* it might be regarded as a work of superrogation to perform some specific test for a complication, if unpredictable complications were, say, ten times as frequent.

The problem is greatly affected by the fact that many patients need blood quickly and that blood has a fairly short effective life. If blood transfusions could always be requested some twenty-four hours before they were needed, then stringent precautions might reasonably be taken ; but most patients need blood in 2·4 hours, or twenty-four minutes—a period far too short to permit the performance of every special test which ingenuity could devise. In practice compromise is essential—compromise

between the demands of a perfectionist and the urgent needs of the patient. Since every transfusionist, however able, may one day be a witness at an inquest, he must be prepared to explain his actions in a court of law, and explain them coherently in simple non-technical language, quoting if necessary from the medical literature. He would be well advised to keep a card-index in which he enters a summary of current literature on blood transfusion ; and if not a natural orator he could with advantage practise elocution so that he can be heard in all parts of a small auditorium. Most important of all, he must guard against pomposity and confusing the issue with excessive detail.

CHAPTER II

# THE REGIONAL TRANSFUSION CENTRE

THE key unit for blood transfusion in Britain to-day is the Regional Transfusion Centre, whose function is to procure, store and issue blood which is correctly grouped, sterile and free from dead bacteria, free also from the virus of any communicable disease, and as fresh as possible. As secondary functions it carries out all sorts of blood serum investigations, such as Wassermann and Kahn reactions, tests expectant mothers for the Rhesus factor and Rhesus antibodies, selects and cross-matches blood for transfusion or for studies of cell survival, and investigates transfusion accidents. Some centres lay more stress on one or other of these functions ; in some areas it is usual for hospital laboratories to test expectant mothers for the Rh factor and antibodies, but there also the Regional Transfusion Centre remains the ordinary court of appeal for all difficult problems.

The general organization of Centres is constant. The Director is experienced in all branches of the work, but must perforce be mainly an administrator. He has on his staff a serologist who is responsible for all blood serology ; an organizer who recruits donors and arranges when and where they are to be bled ; and a chief technician who supervises the apparatus and its sterilization. All these have their assistants, and there are a number of clerks and cleaners.

The Directors have regular meetings with the Ministry of Health's advisers, and attempt, so far as is practicable, to attain nation-wide standardization. Their observations sometimes lead to investigations on a specific problem by

individuals who normally work in an entirely different field (Spooner, 1942 ; Spooner and Turnbull, 1942).

The technique used in the North London Regional Transfusion Centre has been outlined by James (1953). A great amount of work has been, and still is being done in selecting the most suitable materials. For example, it has been quite difficult to obtain rubber tubing which does not give up pyrogens or irritants to blood, and is at the same time reasonably tolerant of the sterilizing procedures. It was not unusual to find that the use of rubber tubing of specification A was followed by thrombophlebitis some three or four times more frequently than was the use of tubing of specification B. Problems of this sort continually present themselves to the Regional Transfusion Centres, and are usually investigated ; but since the results are rarely published the Centres get less credit than they deserve for their extreme care in safeguarding patients.

They are also involved in more specially medical problems, ranging from the evaluation of dextran as a plasma substitute (Bull, Ricketts, Squire, Maycock, Spooner, Mollison and Paterson, 1949) to the incidence of hepatitis following transfusion of whole blood, large pool and small pool plasms (Lehane, Kwantes, Upward and Thomson, 1949)—quite apart from evaluation of techniques or study of the survival of transfused red cells.

*The Routine Preparation of Apparatus.* Rubber and glass tubing is cleaned with alkali and swabs which are pulled through the lumen to remove traces of old blood clot. They are then washed free from alkali. After drying the apparatus is assembled, wrapped first in ordinary cellophane, then in cellophane which becomes adhesive when heated, and autoclaved at 20 lb. pressure for thirty minutes. The distilled water is obtained from stills baffled to produce pyrogen-free water ; and when made

up into acid-citrate-dextrose (see Appendix V) it is dispensed into a clean bottle which is capped, and autoclaved at 20 lb. for thirty minutes. The two holes in the cap which expose the rubber washer are covered with adhesive plaster before autoclaving. The plaster is removed only when blood is about to be collected, and renewed as soon as the blood has been collected. It is covered in its turn with a viscose cap which has been stored in a solution of chlorxylenols. Whenever the rubber washer is exposed by removal of the strapping it is swabbed with 70 per cent. alcohol before and after perforation by a needle.

The rigid standards of autoclaving were laid down after a special investigation by Spooner had revealed that some centres had been using temperatures quite inadequate to ensure sterility. This was usually due to a fault in the design of the autoclave (see Chapter VI) which resulted in a failure to discharge air so that the temperature never rose to sterilizing levels. If this fault in design is avoided even 20 minutes at 20 lb. pressure will kill all known spores.

*Pilot Bottles.* Pilot bottles, that is small vessels containing blood taken from the same donor at the same time as that in the main bottle, have never been very popular in Britain, though they are standard practice in many other countries. In early trials they often became infected so that the cells became pan-agglutinable and the serum pan-agglutinating. Further, medico-legal experts have suggested that, since a pilot bottle could be separated from the parent bottle, the testing of blood from a pilot bottle might not be considered a sufficient precaution. Of recent years, however, the design of pilot bottles has improved and the technical skill of transfusionists and technicians has increased to such a degree that neither of these objections need now be regarded as important. Large-scale

trials of pilot bottles in London have been found to be quite satisfactory and they have now been widely adopted.

*Grouping Methods.* When blood has been collected from a donor, that which remains in the rubber tubing is placed in a glass tube which carried the same number as the main blood bottle. These tubes are kept overnight at 4° C. and then prepared for examination. The serum is decanted for Wassermann and Kahn tests, while the cells are grouped and Rh tested, using tube techniques: the serum is also tested for alpha and beta hæmagglutinins.

When performing these mass tests, the tube method is economical of time and labour. The use of " Ministry of Agriculture " wooden blocks to hold the tubes reduces the amount of labelling required, while the prolonged interval between the setting up of a test and the reading thereof allows a single operator to set up hundreds of tests while waiting for the first to develop. Slide tests may permit single tests to be completed more quickly, but they are too laborious for use in a Transfusion Centre. Grouping by adding donors' cells to known alpha and beta serum can be performed by one observer and the reciprocal test, donors' serum with known A and B cells, independently by a second, thus decreasing the chance of error.

A Regional Transfusion Centre thus takes all reasonable precautions that the blood distributed is sterile and of the correct group and Rhesus type ; and that any apparatus issued for use with it is equally reliable. Occasional errors do occur, though very rarely. A few bottles of infected blood were issued in 1941–2, but very few have been discovered since Spooner's recommendations were adopted. At present, the only error which the author can recall was the misgrouping of AB blood as B ; this was discovered during cross-matching, and on reinvestigation the blood proved to be $A_2B$ instead of B, as was claimed ; the $A_2$ antigen was unusually weak. Thus, although blood issued

by a Transfusion Centre is very carefully studied, there is a small risk of error which must be guarded against by reasonably delicate cross-matching between the serum of the recipient and the cells of the donor.

The Medical Research Council Blood Transfusion Reference Laboratory is precisely what its name indicates, a highly specialized laboratory which maintains stocks of cells of known antigenic structure, and antibodies for most known blood cell antigens. This laboratory can therefore in a short time identify with reasonable certainty any known antibody found in a patient's serum. Many transfusion centres perform similar work but with a smaller selection of antigens and antibodies, so that the problems presented to this laboratory are highly selected and rarely simple. In addition to this detective work, the laboratory receives from Regional Centres sera intended for use in blood grouping, standardizes them, if necessary absorbs interfering antibodies, and distributes them as liquid grouping serum or as freeze-dried (lyophilized) grouping serum for use in the tropics. It also prepares in rabbits anti-human globulin serum for use in the anti-globulin test (Coombs test, developing test), and from time to time holds short courses in advanced blood serology.

CHAPTER III

# TRANSPORT OF BLOOD

ONCE blood has been cooled to refrigerator temperature it should be maintained there and prevented from warming up until it is being administered. If stored blood is warmed up to room temperature for a short time, and then cooled again, the survival of erythrocytes in the recipient's circulation may be reduced from a normal life span down to as little as seven days. It follows, therefore, that blood should be transported in insulated, or better still, in refrigerated containers ; this should be the invariable rule for transport between Transfusion Centre and Hospital, and between Hospitals ; and it should generally be adopted for transport within large hospitals, particularly when blood must be immediately available but possibly may not be required, as in the operating theatre. This is particularly important when the organization is such that the bottle must be entered for cross-matching.

We know that between 2 per cent. and 5 per cent. of all bottles of blood are contaminated with saprophytic bacteria during collection ; these few organisms are always, or nearly always, destroyed by the blood in the course of the next few hours. It is not yet known whether this destruction is made more certain by maintaining the blood at 37°, allowing it to cool at room temperature (18–20°), or cooling it as rapidly as possible to refrigerator temperature ; but experimental studies are in progress (James, 1953b).

Refrigerator vans are usually large and heavy, built on a large scale. For blood transfusion work it is rarely necessary to transport more than 300 bottles at one time,

a load of about 400 kg. If the van is properly insulated, it can be cooled by blocks of ice, or by quite a small refrigerator unit.

Smaller containers allowing the transport of two to six bottles can be rectangular boxes containing three spaces, one at each end for a blood bottle, and one in the middle to contain a metal box filled with broken ice and water, these spaces being surrounded by a suitable insulator—compressed cork, bagasse board, foamed plastic of various kinds. A convenient design was published by Zeitlin (1953) ; it is made by Moulded Components (Jablo) Ltd., Mill Lane, Waddon, Croydon, and types for two or three bottles, and one for six bottles are available. They maintain the blood at 4°–6° C. for about twelve hours.