

# BLOOD TRANSFUSION IN CLINICAL MEDICINE

BY

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SECOND EDITION

WITH A FOREWORD BY

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## FOREWORD TO FIRST EDITION

Within the past twelve years the sum total of new knowledge which has been derived from the practice of blood transfusion has been remarkable. In the United States the discoveries of Landsteiner, Levine and Wiener laid the foundations for a swift and astonishing expansion of the subject of blood groups. In Britain the impetus to extend knowledge of blood transfusion came from the outbreak of war. The interchange of knowledge between Britain and the U.S.A., which began soon afterwards and in which many other countries later participated, was an important factor in the speed of advance.

During the early part of the war Dr. Mollison had an opportunity of sharing in many of these developments. He was particularly associated with the testing of new preservative solutions and with the growing realisation that the ability of stored red cells to survive in the patient's circulation after transfusion was the real criterion of successful preservation. This work led naturally to the measurement of the survival of transfused erythrocytes as a method of investigating blood disorders, a field of investigation which till then had been largely neglected. After the war, Dr. Mollison became Director of the Blood Transfusion Research Unit set up by the Medical Research Council and thus had an opportunity of taking up this work again. In a sense, the present book is a record of his experiences, and it shows that he has made good use of his opportunities.

The author has, it seems, three main objects in view: to lay down clearly the techniques necessary for successful transfusion in the varying circumstances in which it is required; to set out as much fundamental knowledge as is vital for intelligent transfusion, and to show how, by modifications in transfusion techniques, new knowledge in human physiology and pathology can be obtained. It is not an easy task, but Dr. Mollison has succeeded admirably for he has written a book which reads easily and contains all the essential information.

Many readers will, I expect, on opening the book turn to the chapters on "Blood Groups" to see 'what he has made of this'. I do not think they will be disappointed, for he has set down clearly and concisely just what is necessary for the clinician.

This wise selection of knowledge is a characteristic of the whole book, and those who read it should find that their understanding

of blood transfusion has been greatly strengthened. It is written too for those who wish to share in the delight of acquiring knowledge through the successful application of new techniques. It is a stimulating book and I hope it will be widely read by those who practise transfusion.

ALAN N. DRURY

Lister Institute,  
London.  
5th June, 1951.

### FOREWORD TO SECOND EDITION

It is now five years since this book was first published and in this period there have been many substantial advances. Dr. Mollison has continued to take an active part in the development of the subject and what he has set down here has again been largely culled from his own experience. A new edition gives the author the opportunity, not only to bring knowledge up to date, but also to re-arrange and re-write the subject matter so as to make it as clear as possible. I am sure that the discriminating reader will appreciate the skill that has gone into the sifting of the available information so that only what is relevant to the practice of transfusion has been included.

A second edition is often the best edition of a series, for it still holds its original enthusiasm, has had its rough corners knocked off and is not weighed down by the ever-increasing volume of data. I am sure that this edition will maintain and extend the reputation which the first edition secured.

ALAN N. DRURY

Institute of Animal Physiology,  
Babraham, Cambridge.  
27th July, 1956.

## PREFACE TO SECOND EDITION

In preparing this edition I have found it necessary to rewrite most of the chapters to take into account the many advances of the past five years. I have taken the opportunity of re-arranging many parts of the book; for example, naturally-occurring and immune antibodies are no longer considered in separate chapters, since the distinction now seems very arbitrary.

In the field of red cell preservation there have been two important advances: the discovery that the addition of purine nucleosides greatly retards the rate of deterioration during storage and the discovery that red cells mixed with glycerol can be frozen and thawed without haemolysis and can be stored for indefinite periods in the frozen state.

Measurement of the survival of red cells *in vivo* has been greatly facilitated by the introduction of the technique of labelling with radio-active chromium. This method has great advantages over the method of differential agglutination; the subject's own red cells can be labelled, thus avoiding the disadvantages of cross-transfusion; accuracy can be obtained with much less difficulty; and the survival of minute amounts of red cells can be estimated. This last feature of the technique makes it possible to study the fate of incompatible cells and much new information has already been obtained. Nevertheless, so far as the measurement of the true life-span of red cells is concerned, results obtained by the method of differential agglutination are easier to interpret and the picture of red cell survival in health and disease obtained by this method a decade or more ago has required little modification.

In blood grouping, the pace of discovery has at last become slower and it seems doubtful whether any new major human blood group systems remain to be found. However, much remains to be discovered about the clinical significance of blood groups and particularly about blood group antibodies. For example there is a strong suggestion that incomplete antibody which does not bind complement, and which behaves in the antiglobulin test as if it were solely gamma globulin, brings about removal of red cells predominantly in the spleen, whatever group specificity the antibody may possess. A comforting development has been the absorption of one blood group system 'Jay' into the old established P system. There is reason to hope that some 'private' blood group

antigens may also be shown to belong to one or other of the main blood group systems.

In the treatment of haemolytic disease of the newborn exchange transfusion now has a firmly established place and it has become possible to give a more dogmatic account of the management of the condition.

Many friends have helped me by reading through parts of the typescript: Dr. A. C. Dornhorst has given me extensive help in discussing the interpretation of red cell survival curves and has read through some other chapters; Dr. D. M. Parkin has read through all the chapters on blood groups; Dr. W. d'A. Maycock has read the chapters dealing with the storage of blood and the unfavourable effects of transfusion; Dr. D. M. T. Gairdner has criticised the chapters dealing with the blood of the newborn; Dr. J. V. Dacie has read the chapter on auto-antibodies, Miss E. W. Ikin the chapter on blood grouping techniques and Dr. I. D. P. Wootton the chapter on the investigation of haemolytic transfusion reactions. Dr. W. R. Pitney had advised me on the role of transfusion in disorders of coagulation. I am most grateful to all of them for their help.

Miss Marie Cutbush has again given me much help in preparing the manuscript for the press and, as acknowledged in the front of the book, has collaborated with me in revising the chapters on blood groups. She has encouraged me to refer to a good deal of work which we have done together but not yet published and the reference 'personal observations' or 'unpublished observations' in almost all cases refers to work done jointly with her.

I am indebted to Miss Dora Burrill for typing the entire manuscript and helping in many other ways to prepare the book for the press. I should also like to acknowledge the help I have had from Mr. Per Saugman of Blackwell Scientific Publications, with whom it has been a pleasure to work.

Thanks are due to the following publishers and journals for permission to reproduce figures originally published by them: Athlone Press (figs. 14, 19, 20, 29, 30 and 54); Blood (figs. 6, 76, 77, 78 and 80); British Journal of Haematology (figs. 49, 50 and 53); Clinical Science (figs. 23, 24 and 33); the Journal of Physiology (figs. 4 and 13); the Lancet (figs. 42, 43, 44, 45, 47 and 48); Transactions of the American Association of Physicians (figs. 56). Fig. 41 was kindly drawn for me by Dr. Scott N. Swisher from data previously published by himself and Dr. L. E. Young.

## PREFACE TO FIRST EDITION

Blood was once regarded as a fluid of infinite complexity, the very essence of life. The blood of each person seemed to carry in it the secrets of individuality. As recently as 1666 it was natural for Mr. Boyle, in writing to Dr. Lower, to speculate in the following terms about the possible effects of cross-transfusion: "... as whether the blood of a mastiff, being frequently transfused into a bloodhound, or a spaniel, will not prejudice them in point of scent".

If each person's blood were as individual as this, transfusion would indeed be complex and would deserve to rank as the most refined branch of medicine. However this early view of the subtlety of transfusion was eclipsed at the beginning of this century by the discovery that the blood of all human beings could be divided into four groups. It seemed that, provided blood of the same group was transfused, one person's blood was indistinguishable from another's. Indeed, it came to be believed that people who belonged to the common group *O* could give their blood to anyone whatsoever. This point of view reached its widest acceptance in the early 1940's, when hundreds of thousands of bottles of group *O* blood were given as a general panacea for the injuries of war, with remarkably satisfactory effects. As a result of this experience, a generation of medical men has grown up believing that blood transfusion is one of the simplest forms of therapy.

And yet, this view of the interchangeability of blood has to be reconciled with the growing knowledge of its immense complexity. There are so many possible combinations of blood group antigens that the commonest of them all occurs in only 2 % of the English population. Indeed, such is the individuality of the blood that, in Race's striking phrase, certain combinations "may never have formed the blood of an Englishman".

The explanation of this apparent paradox — the potential complexity of transfusion and its actual simplicity — lies in the fact that many blood group factors are so weakly antigenic in man that they are not recognised as foreign by the recipient. However, it can no longer be maintained that a knowledge of the *ABO* system constitutes an adequate equipment for the transfusionist, for the role of some of the other systems is by no means negligible. Thus, a book on blood transfusion requires a special account of blood groups, in which the emphasis laid on any one of the antigens

depends mainly upon the part that it plays in incompatibility.

A good understanding of the effects of transfusion requires two further accounts: one of the regulation of blood volume and of the effects of transfusion on the circulation, and one of the survival of the various elements of blood after transfusion. The survival of transfused red cells has become a matter of special interest. Red cells survive for a longer period than any of the other components of blood, and their survival can be estimated with comparative precision by the method of differential agglutination. A study of the survival of transfused red cells has proved of great value in investigating haemolytic transfusion reactions. In addition, it has contributed strikingly to fundamental knowledge in haematology by demonstrating the diminished survival of pathological red cells and the existence of extrinsic haemolytic mechanisms in disease. Transfusions are now not uncommonly given for the purpose of investigation as well as of therapy.

This book is thus composed mainly of an account of blood groups from a clinical point of view and of descriptions of the effects of transfusion on the circulation and of the survival of transfused red cells; it also contains chapters designed to fill in the remaining background of knowledge about the results of transfusion in man. Finally it contains a rather detailed account of haemolytic disease of the newborn. It is addressed to all those who possess an elementary knowledge of blood transfusion and are interested in acquiring a fuller understanding of its effects.

In preparing this book I have had the help and advice of many friends. Dr. J. V. Dacie read through almost all the typescript and made innumerable suggestions for improvements. Dr. A. C. Dornhorst gave me the most extensive help in writing about the interpretation of red cell survival curves, and he is responsible for the simple rules for estimating mean cell life, which I hope that many besides myself will find useful; he has also read through the book during its preparation and given me the benefit of his very wide general knowledge. Dr. J. F. Loutit, Dr. I. D. P. Wootton and Dr. L. E. Young are amongst those who have read certain sections and helped me with their expert advice.

I am even more indebted to Miss Marie Cutbush, who has given an immense amount of time to helping to prepare this book for the press and has, on every page, suggested changes to clarify the meaning of some sentence. In addition she has most generously



encouraged me to quote many joint observations which are not yet published.

Miss Sylvia Mossom was responsible for typing the whole book, often from almost illegible manuscript. I am much indebted to her for her skill and patience.

I am also grateful to Miss Helen Wilson for kindly preparing the drawings which are reproduced as figures 5, 39, 59, 61 and 75. The microphotographs (figs. 16, 17, 38 and 40) were made in the Photographic Department of the National Institute for Medical Research, by courtesy of the Director.

*The British Medical Journal*, *Clinical Science* and *The Lancet* have been so good as to allow the reproduction of certain figures originally published by them.

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