No Biology Background Required To Understand This Book

THE HUMAN BLOOD GROUPS

Utilized in Disputed Paternity Cases and Criminal Proceedings

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Meant to be useful to physicians, attorneys, investigators, and others who might be interested in such matters, this material is presented in a way which does not require much insight into biology on the part of the reader.

This book considers the practical application of human blood group determination and its medico-legal significance.

MOST IMPORTANT: A chapter, "The Accuracy of Blood Group Determinations," describes the way the medico-legal expert must set up the problems and criticize every link in his investigations in order thereby not only to obtain the best possible results, but also to realize their limitations.

124 pages 19 tables

With this book, blood groups can be determined with great certainty. Chapter VII discusses THE RELIABILITY OF BLOOD GROUP DETERMINATIONS CONSIDERING EACH GROUP SEPARATELY. Significant sources of error are given special attention. Also: cautions - safeguards - helpful hints for beginners. EXAMPLE: "High room temperature in summer may give rise to inaccuracy in M-N determinations."

SUMMARIZING: This book tells the whole story and makes it sound as simple as A-B-C.

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The Human Blood Groups

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By

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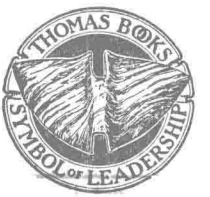

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PREFACE

In 1932 Professor Oluf Thomsen published a book entitled *Human Blood Groups and their Medico-legal Significance* elucidating the problems at issue then. The wide increase in the practical application of blood group determinations since then has given rise to many new problems, and the non-specialist who wishes to study this question today has had but little opportunity to do so.

It is to fill this gap that this book is being submitted. It is meant to be useful to physicians, lawyers and others who might be interested in these matters. The material is presented in a way which does not require much insight into biology on the part of the reader. In the first chapters I have, therefore, omitted the complicated questions, which are not dealt with until later, when the reader has been made familiar with the biological questions of importance in this connection.

The most complicated problems have been reserved for the last chapter *The Accuracy of Blood Group Determinations*, although it would have been more natural to treat some of the questions at an earlier juncture. It is true that this last chapter is not quite so easy to comprehend as the others, but even so I hope that it will prove useful to others than serologists. It describes the way in which the medico-legal expert must set up the problems and criticize every link in his investigations in order thereby not only to obtain the best possible results, but also to realize their limitations. I have tried to include all the rules and provisions which in Denmark apply to blood group determina-

tion and have illustrated their practical application by means of examples, particularly by mentioning a number of judgments in disputed paternity cases.

I have restricted myself to dealing only with judicial practice in Denmark, but the medico-legal considerations proper are not dependent on the laws of the individual countries. Only their practical application depends on such laws.

I take the opportunity to thank Professor Louis le Maire, LL.D., and Hans Topsøe-Jensen, Judge of the Town Court in Copenhagen, who kindly perused the manuscript and who supplied many valuable suggestions in judicial matters.

P.H.A.

Copenhagen, Denmark

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The Human Blood Groups

I

INTRODUCTION

In 1900 Karl Landsteiner published the results of some investigations which immediately showed why it had been so dangerous up to then to transfer blood from one human being to another. Landsteiner found that clumping would often occur if blood from one person was mixed with that of another.

True, this phenomenon had been observed previously, but it had been interpreted as a sign of disease. Landsteiner showed that this reaction was due to completely normal properties in the cells and serum of the blood. He arrived at this result after systematic studies during which he obtained blood samples from 22 subjects and mixed the red cells of each sample with the serum of each of the others. In some cases the blood cells clumped, whereas in others they did not. On the basis of his results, he was able to classify the 22 subjects into three groups.

Within each group, blood cells and serum from different subjects could be mixed without any clumping of the blood cells. Moreover, the blood cells of one of these groups did not clump when mixed with the serum from any of the other groups; in other words, they were unable to clump. On the other hand, the blood cells from the other two groups clumped when mixed with serum from a different group.

Thanks to a new science, serology, which had developed in connection with the great advances made in bacteriology in the course of the last two decades of

the 19th century, Landsteiner was in a position not only to report these experiments, but also to explain the phenomenon. A large number of new facts regarding the blood serum had been learnt, and several substances (antibodies) with strikingly specific effects had been discovered.

Landsteiner's explanation was quite simple. He assumed that the blood cells had two properties, called A and B, the former being present in some individuals and the latter in others, whereas in others again both properties were absent. Corresponding to these properties (*receptors*) in the cells, two different substances (*agglutinins*) were present in the serum; the latter were capable of reacting with the receptors and thereby clumping (*agglutinating*) the blood cells. These agglutinins were called α (Anti-A) and β (Anti-B), and of course the blood serum of an individual did not contain the antibody directed against his own blood cells.

Landsteiner set up three blood groups, but his associates soon found a fourth group in which the blood cells contained both receptors (A and B). Consequently, the serum in this group did not contain any agglutinin.

On this basis, blood group research has developed into an independent branch of serology.

Until his death in 1943, Landsteiner remained the leading personality within this field of research, and in 1930 he was awarded the Nobel Prize, mainly for his discoveries in the science of blood grouping.

In the course of time a considerable number of new properties have been found to be inherent in the blood groups. In the first place, the A-B-O system was extended, since the group called A by Landsteiner was found to be no entity, but made up of several subgroups, A_1, A_2, etc. In addition, other independent systems of blood groups have been recognized including the M-N and the Rh system.

The first practical application of Landsteiner's scheme of blood groups was in blood transfusion. It was now possible to transfer blood from an individual of a given blood group to another individual of the same group and thus avoid the dangerous reactions which previously had prevented the employment of this frequently vital treatment.

The blood groups acquired increased importance after it had been demonstrated that they were subject to simple Mendelian inheritance. If the blood groups of a mother and her child were known, it was easy to figure out those blood group properties which the father of the child must possess. The next step was, quite naturally, the introduction of blood group determinations in disputed paternity cases, since it had to be presumed that non-paternity could be established, if the blood group of the alleged father did not conform to the expectations. This aspect of medico-legal blood grouping has become widely used, and in practice it presents numerous problems with which this volume is mainly concerned.

Medico-legal blood grouping, however, extends beyond disputed paternity cases. The most obvious use is in the study of blood stains, but the method has been extended yet further afield, as the blood receptors have proved to be present not only in the blood cells, but also in other cells of the body and especially in its secretions. These receptors are present in particularly large quantities in the saliva, gastric juice, and semen, and in numerous cases their demonstration is of the utmost medico-legal importance.

At this stage it is not out of place to emphasize the fact that this extension of the blood group properties does not apply universally, as in some individuals the receptors are confined to the blood cells. This peculiar phenomenon is conditioned by inherited factors, so that even this may play a certain rôle in disputed paternity cases.

II

GENERAL DESCRIPTION OF THE BLOOD GROUP PROPERTIES

The A-B-O System

Isoagglutinins

LANDSTEINER's original A-B-O system occupies an exceptional position within blood groups, since receptors as well as the corresponding agglutinins are normal components of the blood. Agglutinins, which thus form part of human blood serum, are called *isoagglutinins*. The system comprises four groups, the properties of which are set out in tabular form below (Table I).

TABLE I

THE PROPERTIES OF THE ORIGINAL A-B-O SYSTEM

Blood Group	Properties: Receptors		Agglutinins		Incidence in %
			Anti	Anti	
	A	B	A	B	
O	−	−	+	+	42
A	+	−	−	+	44
B	−	+	+	−	10
AB	+	+	−	−	4

The incidence of the various groups, given in Table I, is true of the Danish population. The findings have been

rather similar in most European countries and among the white population of North America, but considerable variations have been found within the various races, and blood group determination has, consequently, become a factor of great importance in anthropological investigations. The author does not propose to deal with this aspect of the matter, but will merely illustrate the *striking racial variation of the frequency of the individual blood groups* (Table II).

TABLE II

PERCENTAGE INCIDENCE OF THE BLOOD GROUPS IN CERTAIN RACES

	O	A	B	AB
Indians	100	0	0	0
Gipsies	28	27	35	10
Eskimos	24	56	11	9

In principle, the demonstration of these groups is a very simple matter which may be illustrated by imagining the presence of two subjects belonging to Group A and Group B respectively.

From both subjects a suitable amount of blood is obtained and allowed to stand until it *coagulates*. Some time later, the coagulated blood will divide into two components, a yellow fluid (*serum*) and a firmer mass (the *coagulum*), made up of the blood cells and the protein (*fibrin*) which has stiffened in the process of *coagulation*.

The serum may be separated from the coagulum by centrifuging. Serum from the Group A individual will contain *Anti-B agglutinin*, whereas serum from the Group B individual contains *Anti-A agglutinin*. The reagents for the subsequent blood group determination have then been prepared.

Shaking of the coagula with physiological saline solu-

tion (0.9 per cent) results in a suspension of red blood cells of Group A and Group B respectively which may also be used for grouping tests. The blood group of an individual may then be determined according to the A-B-O system by two methods.

In the first method the blood cells of the subject in question are studied by means of *testing sera:*

(1) Serum containing Anti-A agglutinin (from an individual of Group B).

(2) Serum containing Anti-B agglutinin (from an individual of Group A).

In the second method the serum of the subject in question is studied by means of *testing blood cells:*

(1) A suspension of red blood cells of Group A.

(2) A suspension of red blood cells of Group B.

The procedure is as follows: A blood sample is obtained from the subject. After coagulation has taken place, the serum is separated from the blood cells and a suspension of the red cells is made.

In the first method, which is most commonly used, the suspension of unknown red blood cells is observed for signs of agglutination when they are mixed with the testing sera.

In practice, this process may be watched in several ways, most simply and most commonly, however, by the *slide method:* One drop of Anti-A testing serum and one drop of Anti-B testing serum are transferred to a glass slide (if microscopic examination is desired, to a so-called object-glass). To each drop is then added a drop of the suspension of unknown blood cells. Within five minutes agglutination will take place in one or both drops, provided that the unknown blood cells possess one or both receptors. Fig-

ure 1, which is a photograph of such a reaction, shows that *the reaction is absolutely unmistakable and easy to observe.* The blood group can be read from Table III.

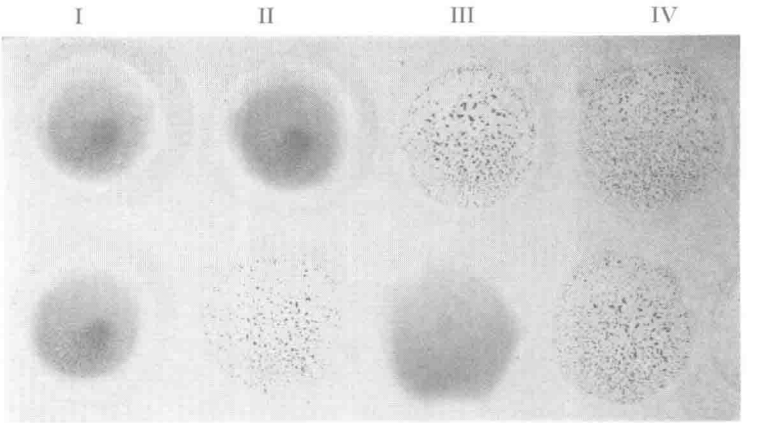

Figure 1. Photograph of agglutination reaction obtained by the slide method with known testing sera.

First row: Anti-B agglutinin.
Second row: Anti-A agglutinin.

I. Reactions with blood cells from an individual of Group O
II. Reactions with blood cells from an individual of Group A
III. Reactions with blood cells from an individual of Group B
IV. Reactions with blood cells from an individual of Group AB

TABLE III

DETERMINATION OF UNKNOWN BLOOD CELLS BY MEANS OF TESTING SERA WITH KNOWN ISOAGGLUTININS

Testing sera	Reactions			
Anti-A	−	+	−	+
Anti-B	−	−	+	+
Result, blood group	O	A	B	AB

In the second method, the procedure is exactly the same with the only exception that drops of two suspensions of known blood cells are transferred to the glass slide and

one drop of the unknown serum is added. The reaction is of the same appearance, and the result may be read from Table IV.

TABLE IV

DETERMINATION OF UNKNOWN BLOOD SERA BY MEANS OF TESTING BLOOD CELLS OF A KNOWN GROUP

Testing Cells	Reactions			
Group O	−	−	−	−
Group A	+	−	+	−
Group B	+	+	−	−
Result, blood group	O	A	B	AB

In principle, the determination is very simple and easy. Before touching upon the numerous serological problems connected with blood group determination, however, it is not out of place to emphasize that in cases where the results are to be employed for medico-legal purposes, the tests place great demands on the examiner who is responsible for the grouping. *It is essential that such an examiner should be not only fully versed in serological methods and problems, but also thoroughly experienced in this special field and preferably familiar with the general principles of medico-legal practice.*

In fact, the blood group determination may be performed solely by watching the reaction of the unknown blood cells with testing sera or solely by watching the reaction of the unknown serum with testing cell suspensions, but in medico-legal practice both methods are used in all cases. In this way, the methods check each other, a principle which is widely used in forensic medicine.

In order to use these determinations for judicial purposes, it is essential to be able to rely completely on the reagents, and this is where the first difficulties are encountered.