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EVIDENCE-THE USE OF BLOOD GROUPING TESTS IN DISPUTED PARENTAGE PROCEEDINGS-A SCIENTIFIC BASIS FOR DISCUSSION

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EVIDENCE—THE USE OF BLOOD GROUPING TESTS IN DISPUTED PARENTAGE PROCEEDINGS—A SCIENTIFIC BASIS FOR DISCUSSION—Much has been written concerning the validity of the so-called "blood-grouping tests" in bastardy and other legal proceedings.[1] The general tenor of the writings is in favor of wider acceptance by the courts of the results of these tests. This comment is to be no exception. How-

[1] See collection of articles in 163 A.L.R. 940, n. 2 (1945).

ever, it is the purpose here to emphasize the scientific validity of the blood-grouping tests and to acquaint the reader with the theory upon which the tests rest. If lawyers and judges understand the scientific basis of the tests, a more intelligent decision upon the validity of any given result can be formed, and the weight which should be given to the results of the tests can be more readily determined.

In addition to the popular *A-B-O* and *M-N* grouping tests now generally in use, this paper will deal also with the *Rh*-factor tests, which are being used more and more widely in determining parentage and which eventually will undoubtedly be accorded the same acceptance as the first two grouping tests.

At present the courts fall into three classifications regarding their acceptance of the blood-grouping tests to determine parentage: (1) those which have not yet passed upon the admissibility and weight to be given the results of the tests; (2) those which admit the results of the tests, but permit the court or the jury to find the facts otherwise than as indicated by the tests;[2] and (3) those which take judicial notice of the validity of the tests, and accept the results as indisputable truth.[3] This comment is directed especially to those who will practice before the courts of the first and second categories. The aim always should be to get the court to take judicial notice of the validity of the results of the blood-grouping tests, for a demonstrable fact is worth far more than the testimony of witnesses.

Herein the attempt will be to state the subject as much in lay terms as is consonant with scientific accuracy.[4] The three grouping methods, *A-B-O, M-N,* and *Rh,* will be discussed in that order; then the three will be brought together to demonstrate their combined potential in determining disputed parentage.

I

A-B-O Grouping Test

Landsteiner discovered the *A-B-O* grouping test in 1901.[5] It is based on the following principles: in the blood of every human being there are red blood cells, called erythrocytes. The outer coating of these

[2] Arais v. Kalensnikoff, 10 Cal. (2d) 428, 74 P. (2d) 1043 (1937); State ex rel. Slovak v. Holod, 63 Ohio App. 16, 24 N.E. (2d) 962 (1939).

[3] Shanks v. State, 185 Md. 437, 45 A. (2d) 85, 163 A.L.R. 931 (1945).

[4] Much of the technical information present in this comment was obtained from Rosa G. Marcos and Alice A. Steele, Medical Technologists at the University of Michigan Hospital. To them the writer is very much indebted.

[5] HARLEY, MEDICO-LEGAL BLOOD GROUP DETERMINATION, 2d ed., 1 (1944).

red blood cells is called the polysaccharide. In the polysaccharide Landsteiner discovered that there may be present a substance called an agglutinogen.[6] He found there were two types of this agglutinogen, and he named the types "*A*" and "*B*". He found that some people had only agglutinogen *A*; others had only agglutinogen *B*; others had both agglutinogens *A* and *B*; and still others had neither agglutinogen. He found further that the presence or absence of this substance was directly related to Mendel's law of heredity.

In every person there are two genes which will determine what agglutinogens will pass to his children.[7] Each of the two genes may contain agglutinogen *A* or *B* or neither. If it contains neither *A* nor *B*, then for convenience it is represented by the letter *O*.[8] As was stated, each person has two genes, and, thus, a person's genetic structure may result in any of the following combinations of genes:

A/A (A in both genes)
A/B (A in one gene and B in the other gene)
A/O (A in one gene and nothing in the other)
B/B (B in both genes)
B/O (B in one gene and nothing in the other)
O/O (Nothing in either gene)

Each primary spermatocyte of the male and primary oocyte of the female contains both the genes mentioned above. During the process of cell division (meiosis), the primary spermatocyte splits into two parts, and at this point the two genes are separated. These divisions become the spermatozoa which will fertilize the female egg. The female primary oocyte has undergone a similar division, and the mature egg contains only one of the two genes which are present in the body.

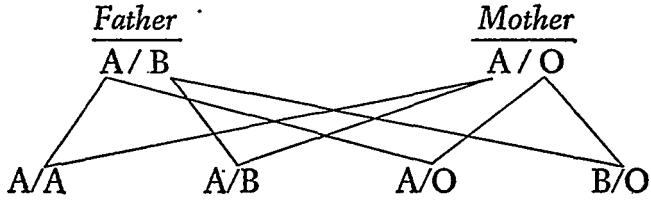
An example will demonstrate this process. Suppose the male genes are of the pattern *A/B*. One gene contains the agglutinogen *A* and the other contains *B*. During cell division, the two are separated so that half the spermatozoa contain the gene for agglutinogen *A* and the other half contain the gene for agglutinogen *B*. Now, suppose that the mother's primary oocyte contains the agglutinogen *A* in one gene and the other gene contains nothing. During cell division they are separated so that half the mature eggs contain agglutinogen *A* and the other

[6] Agglutinogen is defined by WEBSTER'S NEW INTERNATIONAL DICTIONARY, 2d ed. (1941) as: "Any substance which, acting as an antigen, stimulates the production of an agglutinin."

[7] SHULL, HEREDITY, 4th ed., 158 (1948).

[8] This is in accord with the international nomenclature now in general use in scientific work. HARLEY, MEDICO-LEGAL BLOOD GROUP DETERMINATION, 2d ed., 1 (1944).

half contains nothing. It is important to remember that at conception only one spermatozoon and one mature egg unite. The diagram below will demonstrate the possible combinations which the child resulting from the union of the above father and mother may possess:



It is important to note in the above diagram that both genes of the child could not lack any agglutinogen (and thus be *O/O*) because the father would contribute either an *A* or a *B*. Thus, if a child had the genetic pattern *O/O*, the man in the above diagram could not be the father.

If the genetic pattern is *A/A* or *A/O*, the blood type of the person is type "*A*"; if the pattern is *B/B* or *B/O*, the blood type is "*B*"; if the pattern is *A/B* then the blood type is "*AB*"; and if the pattern is *O/O* then the blood type is "*O*".

As stated, the outer coating of the red blood cells contains the agglutinogens *A* and *B* if they are present. If either *A* or *B* is missing in the red cells, then an "anti" substance called an "agglutinin"[9] will be found in the serum of the blood in which the red cells float. If agglutinogen *A* is present in the cells, but there is no *B*, then the serum of the blood will contain an anti-*B* agglutinin which is designated by β. Conversely, if *A* is absent, then the serum will contain anti-A, or α agglutinin. The following table shows the agglutinogens and agglutinins which the cells and serum contain:

Blood Group	*Agglutinogens in red blood cells*	*Agglutinins in the serum*
AB	A B	– –
A	A –	$-\beta$
B	– B	$\alpha -$
O	– –	$\alpha\ \beta$

[9] Agglutinin is defined by WEBSTER'S NEW INTERNATIONAL DICTIONARY, 2d ed., as: "An organic substance producing agglutination; specif., any antibody capable of effecting the agglutination of the specific bacteria or blood cells which stimulated its production."

Agglutinin α will agglutinate or "clump" any red blood cells which contain agglutinogen *A*; β will agglutinate red cells containing *B*. This agglutinating power of the agglutinins is used in testing the blood of an individual to determine his blood type.

It is particularly important that the lawyer acquaint himself with the method of making the tests for blood grouping, not merely to enable himself intelligently to examine a witness who reports the results of the tests, but also to argue effectively to the court that it should take judicial notice of the validity of the tests. The test is made in the following way: A glass slide is marked off into three equal areas with a wax pencil. In the first division the letter "*A*" is inscribed in the corner with the pencil, and the letter "*B*" is inscribed in the second division. Then a drop of the subject's blood is placed in each of the three divisions. In the first division of the slide a drop of serum containing anti-*A* (α) agglutinin is placed on the drop of blood. In the second division, a drop of serum containing anti-*B* (β) agglutinin is placed with the blood. Nothing is mixed with the blood of the third division, for that is merely to serve as a control so that the first and second divisions may be compared with the whole blood.

Agglutination (the process of the cells "clumping" together) may occur in the first division, or the second division, or both divisions, or neither division. In the whole blood, the cells are evenly spread out, but when the blood agglutinates, the cells clump together and this clumping is usually seen readily with the naked eye. Under the microscope the clumping becomes obvious, especially when compared with the whole blood, even to one who is not a technician.

If the blood in the first division of the slide agglutinates, and the blood in the second division does not, then it is clear that the blood of the patient is of the type "*A*". Anti-*A* serum was placed in the first division, and so if there was agglutination, that means that the anti-*A* has reacted with cells containing agglutinogen *A*. Since there was no agglutination in the second division where anti-*B* was placed, that means that there are no *B* agglutinogens present. Thus the patient's blood contains agglutinogen "*A*" and he is therefore of type "*A*". If both the first and second division had agglutinated, that would have indicated that both agglutinogens *A* and *B* were present, and the patient would have the blood type "*AB*". If neither had agglutinated, that would indicate that there is neither agglutinogen *A* nor *B* in the blood, and the patient would be of blood type "*O*".

There are certain factors which may make the test defective, but

they will be discussed, together with the preventative measures, later in this paper.

The blood grouping table using only the factors *A-B-O* is as follows:

Blood group of child	*Blood group of known parent*	*Blood group of unknown parent*
AB	A	B or AB
AB	B	A or AB
AB	AB	A, B, or AB
A	O	A or AB
A	A	O, A, B, or AB
A	B	A or AB
A	AB	O, A, B, or AB
B	O	B or AB
B	A	B or AB
B	B	O, A, B, or AB
B	AB	O, A, B, or AB
O	O	O, A, or B
O	A	O, A, or B
O	B	O, A, or B

II

M-N Grouping Test

In discussing the *M-N* grouping test, much of what was said above will apply here. Landsteiner and Levine, in 1927, discovered two new agglutinogens in the blood which they termed "*M*" and "*N*".[10] Nobody has been found who lacks both of these agglutinogens, so in this grouping there is no group "*O*". The genetic structure as to this agglutinogen is either *M/M*, *N/N* or *M/N*. For example, if the father is *M/M* and the mother is *M/N*, the child may be *M/M* or *M/N*, but it could not be *N/N*, for the father had no *N* agglutinogen to give to the child.

The tests for the *M* and *N* agglutinogens are conducted on much the same principle as tests for the *A-B-O* grouping. The technician makes a 2% saline solution (2 parts blood to 100 parts normal saline) and places two drops of the solution in each of three test tubes. On the first tube he marks the letter "*M*" and on the second he marks the letter "*N*". The third tube is merely to be used for a control and comparison. To the first tube are added two drops of anti-*M* serum, and to the second, two drops of anti-*N* serum are added. This is allowed to stand at room temperature for one hour and then is read microscopically. If agglutination occurs in the tube marked "*M*", it is known that

[10] HARLEY, MEDICO-LEGAL BLOOD GROUP DETERMINATION, 2d ed., 20 (1944).

the cells contain agglutinogen "*M*"; the same is true with the second tube marked "*N*". If agglutination occurs in both first and second tubes, the subject is of the type *M/N*.

To check the sera used in the testing process, blood from a person of known *M/N* type is obtained, and the process is repeated using the known cells. This will show whether the sera used were active enough to get the proper reading.

The inheritance of the *M/N* types is as follows:

Type of parents	*Type of children possible*
M x M	M
M x MN	M, MN
M x N	MN
MN x MN	M, N, MN
MN x N	MN, N
N x N	N

III

Rh Factor

In the "*Rh* factor," so-called from its prevalence in the rhesus monkey,[11] a substantially more complex problem is encountered. Here there are six agglutinogens to deal with. In 1937, Wiener, a student of Landsteiner's, discovered the presence of three agglutinogens which he called *Rh₀, Rh′, and Rh″*, and three others which he has termed *Hr₀, Hr′* and *Hr″*.[12] The inversion of the first two letters in the two groups of agglutinogens symbolizes the fact that the *Rh* agglutinogens are dominant over the *Hr* agglutinogens; that is, in the presence of any one of the *Rh* agglutinogens, the subject will be "*Rh* positive," while it requires a complete lack of the *Rh* agglutinogens and the presence of only the *Hr* agglutinogens to make the subject "*Rh* negative." Race, Fisher, and Morant have simplified the terminology by using the letters *C, D,* and *E* and *c, d, e*. The interrelation of the two nomenclatures is set forth in the following table, and for simplicity the alphabetical denomination will be hereafter used.

Wiener	*Race-Fisher-Morant*
Rh_0	D
Rh′	C
Rh″	E
Hr_0	d
Hr′	c
Hr″	e

[11] SHULL, HEREDITY, 4th ed., 208 (1948).

[12] SCHATKIN, DISPUTED PATERNITY PROCEEDINGS, 2d ed., 138 (1947); Wiener, "Application of the Rh Blood Types and the Hr Factor in Disputed Parentage," 31 J. LAB. & CLIN. MED. 575 (1946).

It is important to note again that each person has two genes which will determine his *Rh* genetic pattern, one of which will pass to the subject's issue, and when combined with the passing gene from the other parent, will comprise the two genes which will make the *Rh* genetic pattern of the child. The subject's genetic structure might be *CDE/CDE*. That symbolizes the fact that the subject contains only the *Rh* positive agglutinogens. On the other hand, the subject might have the genetic pattern *cde/cde*; his genes contain only the negative *Rh* agglutinogens. Between these two extremes, any of 34 other genetic patterns are possible, such as *CDe/cdE, Cde/Cde, cDE/cDe,* etc.[13] It must be understood that each of the two genes will contain *C* or *c and D* or *d and E* or *e*.

Tests can be made for the presence or absence of the six agglutinogens which are similar to the tests for the *A-B-O* and *M-N* blood groups. However, anti-sera are available routinely in laboratories only for the agglutinogens *C, D, E* and *c*. Anti-sera for agglutinogens *d* and *e* are available only experimentally, which raises a problem when the subject is being tested in legal proceedings.

The difficulty may be brought out by examining several hypothetical situations. Suppose the subject's blood is tested with the four anti-sera which are routinely available, and it is determined that a reaction occurs to the agglutinogens *C, D* and *c*. No reaction is had with *E*.[14] What are the genetic patterns possible? It is determined there is *C* and *c* present, and thus it is clear that one gene contains *C* and the other

[13] The following is reprinted from a mimeographed sheet used by the blood bank at the University of Michigan Hospital.

Gene complex	Incidence (Per Cent)	Gene complex	Incidence (Per Cent)
CDe/cde	33.06	cDe/cDe	0.09
CDe/CDe	19.02	cDe/Cde	0.05
cde/cde	14.36	cdE/cdE	0.03
CDe/cDE	11.16	CDe/cdE	0.03
cDE/cde	9.70	cDE/CDE	0.03
CDe/cDe	2.66	cDe/CDE	0.01
cDe/cde	2.31	CDE/cdE	0.01
cDE/cDE	1.64	Cde/Cde	0.01
CDe/cdE	1.48	CDE/Cde	0.002
cdE/cde	1.29	CDE/CDE	0.001
cDE/cDe	0.78	cDe/CdE	0.00
CDe/Cde	0.71	CdE/cDE	0.00
Cde/cde	0.61	CdE/CDe	0.000
cDE/cdE	0.44	CdE/cde	0.000
Cde/cDE	0.21	CdE/cdE	0.000
CDE/CDe	0.11	CdE/Cde	0.000
cDe/cdE	0.10	CdE/CdE	0.000
CDE/cde	0.10	CdE/CDE	0.000

[14] This reaction is obtained in 35.8% of cases.

contains *c*, for they could not both exist in the same gene. We know *D* is present, but since no test has been made for *d*, we do not know whether *D* is present in both genes or whether *D* is present in one gene and *d* is present in the other. On the basis of the tests, there are three genetic patterns possible: *CDe/cde, cDe/Cde* or *CDe/cDe.*

Suppose the subject, when tested with the four anti-sera, reacted to all four tested agglutinogens, *C,D,E* and *c*. The only thing that can be determined with certainty is that both genes will not contain *C*, and both will not contain *c*, for inasmuch as each is present there will be a *C* in one gene and a *c* in the other. Thus, there are nine possible genetic patterns: *CDe/cDE, cDe/CDE, CDe/cdE, Cde/cDE, CDE/cde, cDe/CdE, cDE/CDE, CDE/cdE* and *CdE/cDE.*

The easiest case, of course, is where no reaction is had with the agglutinogens *C, D* and *E*, and reaction is only had with *c*. This means that there is no *C, D* and *E* in the subject's blood, and therefore the subject must be a homozygous[15] negative with the genetic pattern *cde/cde.*

With the technical problem in mind, some hypothetical bastardy proceedings will help make the legal difficulties apparent. To simplify matters, a case will be first supposed where only the *Rh* factor of the child and the alleged father are known reserving until later the more complex situation utilizing the grouping of the mother also. Suppose that when the blood of the child is tested, a reaction is obtained only to the testing serum for *C* and *D*. Since no reaction is obtained to the testing serum for *c*, each gene of the child must contain *C*; neither can contain *c*. We then can eliminate the father if, when his blood is tested, we get no reaction for the agglutinogen *C*, but only for the agglutinogen *c*, since this would indicate the presence of agglutinogen *c* in both genes, and consequently the presence of agglutinogen *c* in at least one gene of any child of his.

In another case, suppose the blood of the child contained the agglutinogens *C, E* and *c*. In this case, no alleged father could be *excluded* without also testing the mother. One might inquire: "But if we tested the alleged father, and found a reaction to the agglutinogen *D*, how could he be the father?" The answer is this: Assume a reaction to the agglutinogen *D* in the father. But since there is no anti-sera available to test for *d*, we do not know whether the man has *D* in both genes, or whether the genetic structure is *D/d*. If the genetic structure was in

[15] Homozygous: containing either member (not both) of at least one pair of allelomorphic Mendelian characters. Thus, here the subject contains only the negative agglutinogens, not the positive agglutinogens.

fact *D/D*, then it is true that the man could not be the father of the child, for he would have had to pass the agglutinogen *D* in one or the other of the genes. But since we cannot test for *d*, we do not know whether the genetic structure (as to the *D* agglutinogen) was *D/D* or *D/d*. If the latter, he could have passed to the child a *d* which would not have shown up when the child's blood was tested.

The following is a table showing the blood of the child, and the possibility of excluding the alleged father, without the use of the mother's grouping:

*Child's reaction with anti-Rh sera**	*Reaction of alleged father which would exclude him*	*Reaction of alleged father which would not exclude him*
C	c, DEc, Dc, Ec	C, CD, CE, Cc, CDE, CDEc, CEc, CDc
CD	c, DEc, Dc, Ec	"
CE	c, DEc, Dc, Ec	"
CDE	c, DEc, Dc, Ec	"
CDEc	None possible	All possible
c	CD, CDE, C, CE	Cc, Dc, Ec, c, CDEc, CEc, CDc, DEc
Dc	CD, CDE, C, CE	"
Ec	CD, CDE, C, CE	"
DEc	CD, CDE, C, CE	"
CDc	None possible	All possible
CEc	None possible	All possible
Cc	None possible	All possible

*The letter indicates a reaction, and thus the presence of the agglutinogen.

The *Rh* grouping of the mother may now be added to the situation. By way of example, the foregoing hypothetical situation will be used where the child's blood showed the presence of the agglutinogens *C*, *E* and *c*. It was shown that no man could be excluded as the father of the child on the basis only of his blood and that of the child. However, when the blood grouping of the mother is also known, definite exclusions are possible. If the mother's blood showed the presence only of *C* and not *c*, and the father's blood also showed only the presence of *C* and not *c*, he could be excluded on two grounds. (1) The child has agglutinogen *D*, which did not come from the mother, and could not have come from the father (because *D* did not show up in either parent). (2) The child has agglutinogen *c*, which did not come from the mother and could not have come from the father. On the other hand, assume that the mother's blood showed the presence of agglutinogens *C*, *D*, *E* and *c*. Here, no man could be excluded as the father of the child. The mother has all the agglutinogens necessary to make up the child's genetic pattern, and when they are arranged in the nine possible combinations mentioned above, they could combine with any possible

genetic combination which the man might have, to produce the genetic pattern of the child.

Set forth below is a table showing all the possible exclusions of parentage when the blood of the child and mother are known. Across the top are the twelve possible reactions which may be obtained from the blood of the mother when tested with the four anti-sera. The letters indicate the presence of that agglutinogen in the blood. Down the left side are the twelve possible reactions which may be obtained when the blood of the child is tested. In the body of the table are set forth all the reactions to the blood of the alleged father which would *exclude* him as the father of the child. It should be kept in mind when reading the table that if the letter *C* is present without *c*, that indicates *C* is present in *both* genes. The same is true for *c*, without the presence of *C*. Thus, if the genetic patterns are

Child CE
Mother CE
Father Ec

the father is excluded because the mother passed a *C*, but the father could pass only *c*, so the child could not possess a *C* in both genes if the alleged father was in fact the parent. A rule of explanation with respect to any particular combination will be found in the answer to the following question: what agglutinogen does the child possess which it did not get from the mother, and which could not be provided by the alleged father if his blood reacts as shown in the table?

FRATERNAL BLOOD TYPES EXCLUDED

Agglutinogens found to be present in Child's Blood	Agglutinogens Found to be Present in Mother's Blood											
	C	CD	CE	CDE	CDEc	c	Dc	Ec	DEc	CDc	CEc	Cc
C	c Dc Ec DEc	c Dc Ec DEc	C Dc Ec DEc	c Dc Ec DEc	c Dc Ec DEc	*	*	*	*	c Dc Ec DEc	c Dc Ec DEc	c Dc Ec DEc
CD	C CE c Dc Ec DEc CEc Cc	c Dc Ec DEc	C CE c Dc Ec DEc CEc Cc	c Dc Ec DEc	c Dc Ec DEc	*	*	*	*	c Dc Ec DEc	C CE c Dc Ec DEc CEc Cc	C CE c Dc Ec DEc CEc Cc
CE	C CD c Dc Ec DEc CDc Cc	C CD c Dc Ec DEc CDc Cc	c Dc Ec DEc	c Dc Ec DEc	c Dc Ec DEc	*	*	*	*	C CD c Dc Ec DEc CDc Cc	C Dc Ec DEc	C CD c Dc Ec DEc CDc Cc
CDE	C CD CE c Dc Ec DEc CDc CEc Cc	C CD c Dc Ec DEc CDc Cc	C CE c Dc Ec DEc CEc Cc	c Dc Ec DEc	c Dc Ec DEc	*	*	*	*	C CD c Dc EC DEc CDc Cc	C CE c Dc Ec DEc CEc Cc	C CD CE c Dc Ec DEc CDc CEc Cc
CDEc	C CD CE CDE c Dc Ec CDc CEc Cc	C CD CE CDE c Dc CDc Cc	C CD CE CDE c Ec CEc Cc	C CD CE CDE	None	C CD CE c Dc Ec DEc CDc CEc Cc	C CD c Dc Ec DEc CDc Cc	C CE c Dc Ec DEc CEc Cc	c Dc Ec DEc	C CD c Dc CDc Cc	C CE c Ec CEc Cc	C CD CE c Dc Ec CDc CEc Cc
c	*	*	*	*	C CD CE CDE	C CD CE CDE	C CD CE CDE	C CD CE CDE	C CD CE CDE	C CD CE CDE	C CD CE CDE	C CD CE CDE
Dc	*	*	*	*	C CD CE CDE	C CD CE CDE c Ec CEc Cc	C CD CE CDE	C CD CE CDE c Ec CEc Cc	C CD CE CDE	C CD CE CDE	C CD CE CDE c Ec CEc Cc	C CD CE CDE c Ec CEc Cc

*Indicates impossible genotype for mother.

FRATERNAL BLOOD TYPES EXCLUDED—Continued

Agglutinogens found to be present in Child's Blood	Agglutinogens Found to be Present in Mother's Blood											
	C	CD	CE	CDE	CDEc	c	Dc	Ec	DEc	CDc	CEc	Cc
Ec	*	*	*	*	C CD CE CDE	C CD CE CDE c Dc CDc Cc	C CD CE CDE c Dc CDc Cc	C CD CE CDE	C CD CE CDE	C CD CE CDE c Dc CDc Cc	C CD CE CDE	C CD CE CDE c Dc CDc Cc
DEc	*	*	*	*	C CD CE CDE	C CD CE CDE c Dc Ec CDc CEc Cc	C CD CE CDE c Dc CDc Cc	C CD CE CDE c Ec CEc Cc	C CD CE CDE	C CD CE CDE c Dc CDc Cc	C CD CE CDE c Ec CEc Cc	C CD CE CDE c Dc Ec CDc CEc Cc
CDc	C CD CE CDE c Ec CEc Cc	C CD CE CDE	C CD CE CDE c Ec CEc Cc	C CD CE CDE	None	C CE c Dc Ec DEc CEc Cc	c Dc Ec DEc	C CE c Dc Ec DEc CEc Cc	c Dc Ec DEc	None	C CE c Ec CEc Cc	C CE c Ec CEc Cc
CEc	C CD CE CDE c Dc CDc Cc	C CD CE CDE c Dc CDc Cc	C CD CE CDE	C CD CE CDE	None	C CD c Dc Ec DEc CDc Cc	C CD c Dc Ec DEc CDc Cc	c Dc Ec DEc	c Dc Ec DEc	C CD c Dc CDc Cc	None	C CD c Dc CDc Cc
Cc	C CD CE CDE	C CD CE CDE	C CD CE CDE	C CD CE CDE	None	c Dc Ec DEc	c Dc Ec DEc	c Dc Ec DEc	c Dc Ec DEc	None	None	None

*Indicates impossible genotype for mother.

IV

Combined Potential

It is apparent that by using the three blood grouping tests, *A-B-O*, *M-N*, and *Rh*, the possibility of excluding an alleged father is increased over the use of only one or two of the tests. Each test independently may prove nonpaternity, but when two or three tests are run, the

chances of exclusion are greatly increased. The expected rate of establishment of nonpaternity by the *A-B-O* and *M-N* tests, based on the assumption that all the men are falsely accused, is 30%.[16] Dr. Harley reports a series of 65 disputed paternity cases, in ten of which nonpaternity was established. The rate there is only 15%, which suggests that half the men were falsely accused and the other half were in fact the fathers.[17] With the addition of the *Rh* tests, the rate of exclusion of falsely accused men rises well over the 30% obtained with the use only of the *A-B-O* and *M-N* tests. Mr. Schatkin states that today, through the use of all three tests, 50% of wrongfully accused men can be excluded.[18]

V

Sources of Error

Some possible sources of errors should be pointed out, together with the technique for their elimination, so that the courts can determine that an accurate test has been made upon any given individual.

1. *Rouleaux formation:* Under certain conditions, the red blood cells may clump together in such a way that it appears at first glance that true agglutination has taken place. This is called rouleaux formation. Upon closer examination, however, the cells are seen to lie in rows within the groups, like a roll of pennies.[19] A competent laboratory technician can detect this formation as rouleaux, and not true agglutination. The technician should be asked whether he inspected the blood under the microscope to determine whether the reaction was true agglutination, or rouleaux formation. When in doubt, the technician can dilute the serum with an equal amount of physiologic salt solution, which eliminates rouleaux formation, but does not affect true clumping.[20]

2. *Weak testing serum:* Occasionally the agglutinating power of the serum may be so low as to result in a false negative reading.[21] This may be guarded against in three ways: (1) two different bottles of testing serum, obtained at different times by the laboratory may be used in making the tests; (2) the technician may take some serum from a

[16] HARLEY, MEDICO-LEGAL BLOOD GROUP DETERMINATION, 2d ed., 58 (1945).
[17] Id. at 56-58.
[18] SCHATKIN, DISPUTED PATERNITY PROCEEDINGS, 2d ed., 158-159 (1947).
[19] TODD AND SANFORD, CLINICAL DIAGNOSIS BY LABORATORY METHODS, 11th ed., 170, 323 (1948).
[20] Id. at 323.
[21] Ibid.

person of known blood type, and use it to make the tests, to check the results obtained by the commercial serum; (3) the commercial serum may be used to test the blood of a person with known blood type, to see that it is strong enough to effect the expected result.

3. *Incomplete development of the child's blood group at birth:* In a few cases, it has been found that the agglutinating power of the infant's blood is so low at birth that a correct blood grouping cannot be had immediately. In that case, a decision may have to be postponed until the child's group is fully established.[22] However, by the age of six months, an accurate determination can always be had.

Perhaps the best way to safeguard against errors is to have the blood tests made independently by two or more laboratories. This would make the chance for error negligible, and is recommended in all cases where the controversy is actually to be brought to trial. In a recent Maine case, the tests had been run eleven times, with the same result each time.[23] The court made special mention of the fact, and it proved to be a factor in the determination by the court that it should take judicial notice of the validity of the blood grouping tests.

VI

Judicial Application

Most of the legal profession is acquainted with the result reached in the *Chaplin* case in California.[24] The genetic patterns in controversy were as follows:

Charles Chaplin	O MN
Joan Berry (mother)	A N
Carol Ann Berry	B N

Diagrammatically, the union of Mr. Chaplin and Miss Berry could produce the following genetic patterns in an offspring:

Chaplin	*Joan Berry*	*Possible offspring*
O/O	A/A	A/O, A/O, A/O, A/O
	or	
	A/O	A/O, A/O, O/O, O/O

It would be impossible for either Chaplin or the mother to pass the gene for *B* agglutinogen which showed up in Carol Ann, since neither

22 HARLEY, MEDICO-LEGAL BLOOD GROUP DETERMINATION, 2d ed., 4 (1945).
23 Jordan v. Mace, (Me. 1949) 69 A. (2d) 670.
24 Berry v. Chaplin, 74 Cal. App. (2d) 652, 169 P. (2d) 442 (1946).

had such a gene. Yet, following a prior decision of the Supreme Court of California,[25] the court of appeals held that the jury was entitled to find that Chaplin was the father of the child.

At least two courts, Maine and Maryland, appear to have taken judicial notice of the validity of the *A-B-O* and *M-N* grouping tests.[26] As the Maryland court said in taking notice of the validity of the tests, "Blood tests are now accepted everywhere, scientifically, as accurate, and the courts and legislatures have generally followed the same view."[27]

The court seems to overstate the degree of acceptance by the courts in general, though perhaps it shows a trend which will be followed as more and more courts pass upon the question.

The courts of Maine must now be said to accord judicial notice to the blood-grouping tests, although the court in the recent case of *Jordan v. Mace*[28] merely tried to distinguish the prior case of *Jordan v. Davis*.[29] In the *Davis* case, the court had held that the jury could make a finding contrary to the result of the blood-grouping tests, but it held in the *Mace* case that the defendant was entitled to a new trial when the jury reached a verdict opposed to the result of the blood grouping tests. It attempted to distinguish the *Davis* case on the ground that there was no showing that the tests were accurately conducted there. Thus, it is apparently the law of Maine at this time that if the jury finds that the tests were accurately conducted, it cannot disregard the results in reaching its verdict.

The recent case of *Hill v. Johnson*[30] shows the rigidity with which the California courts follow the Chaplin-Kalensnikoff line of reasoning. Mrs. Hill was married at the time her child was conceived, though her testimony was that she did not have intercourse with her husband during the period of conception. She charged defendant with being the father of the child. The trial court admitted evidence that Mr. and Mrs. Hill were of blood type *"O"* and that the child was of type *"B"*, and, in the face of a conclusive statutory presumption of legitimacy when a child is conceived during wedlock, gave judgment for plaintiff. The district court of appeals reversed, saying: "Evidence of the result of a blood test is to be considered with all other evidence in the case and

[25] Arais v. Kalensnikoff, 10 Cal. (2d) 428, 74 P. (2d) 1043 (1937).

[26] Shanks v. State, 185 Md. 437, 45 A. (2d) 85, 163 A.L.R. 931 (1945); Jordan v. Mace, (Me. 1949) 69 A. (2d) 670.

[27] Shanks v. State, 185 Md. 437 at 440, 45 A. (2d) 85 (1945).

[28] (Me. 1949) 69 A. (2d) 670.

[29] 143 Me. 185, 57 A. (2d) 209 (1948).

[30] 102 Cal. App. (2d) 94, 226 P. (2d) 655 (1951).

is not conclusive. . . . It was error to admit the evidence since it is contrary to the conclusive presumption of legitimacy."[31]

At least three states have enacted statutes providing for admissibility of the tests in bastardy proceedings, but none of the statutes in terms make the findings binding upon the parties.[32]

Because the question of the weight to be accorded the blood-grouping tests has not yet reached the highest courts of the majority of our states, there is great opportunity for lawyers to make a convincing argument that the grouping tests should be accorded judicial notice. But to do this, the lawyer must convince the court of the accuracy and reliability of the tests. Before he attempts to present the matter to the court he must be thoroughly familiar with the underlying theory of the tests, not only that he may convince the court that he knows what he is talking about, but also that he may intelligently examine the expert serologist witness who will aid him in convincing the court of the validity of the tests made. For the lawyer who opposes admission of the test, a thorough knowledge of the subject is necessary to effective cross-examination aimed at detecting errors in the manner in which the tests were conducted.

In states where the test is accepted, but accorded no greater weight than other expert testimony, two possibilities of getting the court to accord it the status of a judicially noticed fact exist: (1) legislation making the results of the test conclusive of nonpaternity, and leaving to the jury only the question of whether the tests were accurately conducted; (2) convince the courts (as was done in *Jordan v. Mace*) that the tests are now *worthy* of judicial notice.

But it always must be kept in mind that this "cultural lag"[33] cannot be prevented unless members of the bar are themselves acquainted with the theory and practice underlying the three blood-grouping tests in order to convince the courts that the three tests *are* worthy of judicial recognition.

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[31] Id. at 96. Query as to the due process aspect of the legislative enactment. Can the legislature make a presumption conclusive as against a contrary physical law? Cf. State ex rel. Walker v. Clark, 144 Ohio St. 305, 58 N.E. (2d) 773 (1944).

[32] *Maine:* Maine Laws, 1939, c. 259; *Ohio:* Ohio Gen. Code Ann., §12122-1; *Wisconsin:* Wis. Stat. (1937) §325.23. A possible addition may be found in §306a (1939) of the New York Civ. Practice Act.

[33] Britt, "Blood-Grouping Tests and More 'Cultural Lag,'" 22 MINN. L. REV. 836 (1938).