

[Start with listings with each line having hyperlink to full section in the rest of this document.]

## ABO BLOOD GROUP SYSTEM

Anti-A.

Anti-B

Anti-A<sub>1</sub>

## MNS BLOOD GROUP SYSTEM

Anti-M

Anti-N

Anti-S

Anti-s

Anti-U

Antibodies to Low-Incidence Antigens in the MNS Blood Group System

Antibodies to High-Incidence Antigens in the MNS Blood Group System

Anti-En<sup>a</sup>

## P BLOOD GROUP SYSTEM

Anti-P

## Rh BLOOD GROUP SYSTEM

Anti-D

Anti-C

Anti-C<sup>w</sup>

Anti-E

Anti-c

Anti-e

Anti-Ce

Anti-f

Anti-G

Anti-V

Anti-Rh17

Anti-Rh29

Anti-hr<sup>S</sup>

Anti-hr<sup>B</sup>

Antibodies to Low-Incidence Antigens in the Rh Blood Group System

#### LUTHERAN BLOOD GROUP SYSTEM

Anti-Lu<sup>a</sup>

Anti-Lu<sup>b</sup>

Anti-Lu3

Antibodies to High-Incidence Antigens in the Lutheran Blood Group System

Antibodies to Low-Incidence Antigens in the Lutheran Blood Group System

#### KELL BLOOD GROUP SYSTEM

Anti-K

Anti-k

Anti-Kp<sup>a</sup>

Anti-Kp<sup>b</sup>

Anti-Js<sup>a</sup>

Anti-Js<sup>b</sup>

Anti-Ku

Antibodies to High-Incidence Antigens in the Kell Blood Group System

Antibodies to Low-Incidence Antigens in the Kell Blood Group System

#### LEWIS BLOOD GROUP SYSTEM

Anti-Le<sup>a</sup>

Anti-Le<sup>b</sup>

Anti-Le<sup>x</sup>

#### DUFFY BLOOD GROUP SYSTEM

Anti-Fy<sup>a</sup>

Anti-Fy<sup>b</sup>

Anti-Fy<sub>3</sub>

#### KIDD BLOOD GROUP SYSTEM

Anti-Jk<sup>a</sup>

Anti-Jk<sup>b</sup>

Anti-Jk<sub>3</sub>

#### DIEGO BLOOD GROUP SYSTEM

Anti-Di<sup>a</sup>

Anti-Di<sup>b</sup>

Anti-Wr<sup>a</sup>

Antibodies to Low Incidence Antigens in the Diego Blood Group System

#### YT BLOOD GROUP SYSTEM

Yt antigens are carried on acetylcholinesterase.

Anti-Yt<sup>a</sup>

Anti-Yt<sup>b</sup>

#### Xg BLOOD GROUP SYSTEM

Anti-Xg<sup>a</sup>

#### SCIANNA BLOOD GROUP SYSTEM (ISBT 013)

Anti-Sc1

Anti-Sc2

#### DOMBROCK BLOOD GROUP SYSTEM

Anti-Do<sup>a</sup>

Anti-Do<sup>b</sup>

Anti-Gy<sup>a</sup>

Anti-Hy

Anti-Jo<sup>a</sup>

#### COLTON BLOOD GROUP SYSTEM

Anti-Co<sup>a</sup>

Anti-Co<sup>b</sup>

#### LANDSTEINER-WIENER BLOOD GROUP SYSTEM

Anti-LW<sup>a</sup>

Anti-LW<sup>b</sup>

#### CHIDO/RODGERS BLOOD GROUP SYSTEM

Anti-Ch

Anti-Rg

Hh BLOOD GROUP SYSTEM

Kx BLOOD GROUP SYSTEM

Anti-Kx

GERBICH BLOOD GROUP SYSTEM

Anti-Ge

Antibodies to Low-Incidence Antigens in the Gerbich Blood Group System

CROMER BLOOD GROUP SYSTEM

Anti-Cr<sup>a</sup>

Antibodies to high-Incidence Antigens in the Cromer Blood Group System

Antibodies to Low-Incidence Antigens in the Cromer Blood Group System

KNOPS BLOOD GROUP SYSTEM

Anti-Kn<sup>a</sup>

Anti-McC<sup>a</sup>

Anti-SI<sup>a</sup>

Anti-Yk<sup>a</sup>

INDIAN BLOOD GROUP SYSTEM

Anti-In<sup>a</sup>

Anti-In<sup>b</sup>

Ok BLOOD GROUP SYSTEM

Anti-Ok<sup>a</sup>

Ii BLOOD GROUP COLLECTION

Anti-I

Anti-IH

Anti-I<sup>T</sup>

Anti-i

#### Er BLOOD GROUP COLLECTION

Anti-Er<sup>a</sup>

#### GLOBOSIDE BLOOD GROUP COLLECTION

Anti-P+P<sub>1</sub>+P<sup>k</sup>

Anti-P

Donath-Landsteiner Antibody

#### SERIES OF HIGH INCIDENCE ANTIGENS

Anti-AnWj

Anti-At<sup>a</sup>

Anti-JMH

Anti-Jr<sup>a</sup>

Anti-Lan

Anti-Sd<sup>a</sup>

Anti-Vel

#### OTHER BLOOD GROUP ANTIGENS

Anti-Bg

Anti-Bg<sup>a</sup>

Anti-Pr

Anti-Rx

## **ABO BLOOD GROUP SYSTEM**

### ***Anti-A***

**CLINICAL:** Anti-A occurs naturally in the serum of all group O or group B individuals. The antibody may cause severe hemolytic transfusion reactions if incompatible blood is given. Most fatal transfusion reactions are caused by inadvertent use of ABO group incompatible blood. Anti-A is a fairly common cause of HDN, although most cases are mild. Exchange transfusion of babies affected with ABO group HDN should be made with group O red cells.

**TECHNICAL:** Anti-A may be IgM or IgG and of high titer. Both antibodies cause strong direct agglutination of group A red cells. The severity of transfusion reactions or HDN is correlated with the level of potent IgG complement-binding anti-A in the recipient or maternal serum.

### ***Anti-B***

**CLINICAL:** Anti-B occurs as a natural antibody in the serum of group O and group A people. The antibody may cause HDN which is usually mild, and severe transfusion reactions if incompatible blood is given.

**TECHNICAL:** Anti-B may be IgM or IgG and causes strong direct agglutination of group B red cells. The most severe clinical effects are associated with potent IgG complement binding anti-B.

### ***Anti-A<sub>1</sub>***

CLINICAL: Anti-A<sub>1</sub> is almost always a naturally-occurring cold agglutinin that does not cause hemolytic transfusion reactions or HDN. It is not necessary to select A<sub>2</sub> blood for transfusion unless the antibody reacts at 37°C .

TECHNICAL: Anti-A<sub>1</sub> is nearly always an IgM cold agglutinin found in about 1% of A<sub>2</sub> people and 25% of A<sub>2</sub>B people. About 80% of group A bloods are subgroup A<sub>1</sub>.

## **MNS BLOOD GROUP SYSTEM**

### ***Anti-M***

CLINICAL: Numerous examples of anti-M have been recognized, many of them being of apparent natural occurrence. Most are not clinically significant and can be ignored for transfusion purposes. On very rare occasions potent IgG anti-M active at 37EC has caused HDN. Patients with rare examples of anti-M that cause agglutination of M-positive red cells at 37EC should be transfused with M-negative blood as a precaution.

TECHNICAL: Most examples of anti-M are IgG but only react below body temperature causing direct agglutination of M-positive red cells. About 20% of random donors are M-negative. Technical problems with this antibody in the compatibility test can usually be avoided by performing the test strictly at 37EC.

### ***Anti-N***

CLINICAL: Anti-N is an uncommon antibody that does not cause hemolytic transfusion reactions or HDN. Selection of N-negative blood for transfusion is not necessary and the antibody can be ignored. Rare examples of a variant form of anti-N are only compatible with N-U- red cells and may be clinically significant.

TECHNICAL: Anti-N is usually a direct agglutinin that reacts with about 70% of random bloods. Technical problems with this antibody in the compatibility test can usually be avoided by performing the test strictly at 37EC.

### ***Anti-S***

CLINICAL: Anti-S can be naturally-occurring or immune and may cause a brisk hemolytic reaction to an incompatible blood transfusion and a few examples have caused HDN. S-negative blood should be selected for transfusion.

TECHNICAL: Anti-S can be a direct agglutinating antibody or be reactive by the antiglobulin test. About 48% of random bloods are S-negative.

### ***Anti-s***

CLINICAL: Anti-s is an immune antibody. On rare occasions it has caused a hemolytic transfusion reaction or HDN. While most examples of anti-s are probably benign, it is recommended that s-negative blood be used for transfusion.

TECHNICAL: Anti-s is usually reactive by the antiglobulin test; some examples are direct agglutinating cold agglutinins. About 12% of bloods are s-negative.

***Anti-U***

CLINICAL: Anti-U is an immune antibody found in some Black people that reacts with a high-incidence red cell antigen. Alloanti-U has never been found in blood from a White person. The antibody may cause severe transfusion reactions or severe HDN. U-negative blood must be used for transfusion.

TECHNICAL: Anti-U is IgG and reacts by the antiglobulin test. All Whites are U-positive but about 1 in 100 Blacks are U-negative. Variants of the U antigen and anti-U may be encountered.

***Antibodies to Low-Incidence Antigens in the MNS Blood Group System***

CLINICAL: Antibodies have been found that define low-incidence antigens in the MNS blood group system named: Cl<sup>a</sup>, DANE, Dantu, ERIK, Far, HAG, He, Hil, Hop, Hut, MARS, M<sup>c</sup>, M<sup>e</sup>, M<sup>g</sup>, Mi<sup>a</sup>, MINY, Mit, Mt<sup>a</sup>, Mur, MUT, M<sup>v</sup>, Nob, Ny<sup>a</sup>, Or, Os<sup>a</sup> Ri<sup>a</sup>, s<sup>D</sup>, SAT, St<sup>a</sup>, TSEN, Vr, Vw. These antigens are well developed on red cells from newborn babies of positive phenotype, and any of the antibodies may be a rare cause of HDN. Almost all random donors will be compatible and there is no difficulty in finding blood for transfusion.

TECHNICAL: Antibodies to these low-incidence antigens may be IgG or IgM; many appear to be naturally occurring.

## ***Antibodies to High-Incidence Antigens in the MNS Blood Group System***

### ***Anti-En<sup>a</sup>***

CLINICAL: Anti-En<sup>a</sup> is an immune antibody that reacts with high-incidence antigens present on glycophorin A, the major sialoglycoprotein of the red cell membrane. These antibodies may cause transfusion reactions or HDN. It is difficult, if not impossible, to find compatible donor blood.

TECHNICAL: Anti-En<sup>a</sup> is usually IgG and reacts by the antiglobulin test. Anti-En<sup>a</sup> reacts variably in serological methods using proteases, depending on the location of the specific antigen on glycophorin A. Siblings of these patients should be tested for compatibility, and patients urged to donate blood for long term cryogenic storage when their clinical state permits.

## **P BLOOD GROUP SYSTEM**

### ***Anti-P***

CLINICAL: Anti-P<sub>1</sub> is a fairly common naturally-occurring antibody that does not cause transfusion reactions or HDN. It is not necessary to select P<sub>1</sub>-negative blood for transfusion. On very rare occasions IgG anti-P<sub>1</sub> has caused a hemolytic reaction to the transfusion of P<sub>1</sub> red cells. These rare clinically significant antibodies can be recognized by their distinctive serological characteristic.

TECHNICAL: Anti-P<sub>1</sub> is nearly always a direct agglutinating antibody active at low temperature. About 21% of bloods are P<sub>1</sub>-negative. Technical problems with this antibody in the

compatibility test can usually be avoided by performing the test strictly at 37°C. Exceptional anti-P<sub>1</sub> antibodies, that are clinically important, are IgG and easily recognized by their ability to hemolyze P<sub>1</sub>-positive test red cells at 37°C. Anti-P<sub>1</sub> can be inhibited by soluble P<sub>1</sub> substance.

## **Rh BLOOD GROUP SYSTEM**

### ***Anti-D***

**CLINICAL:** Anti-D can cause severe hemolytic transfusion reactions if D-positive red cells are transfused, or severe HDN in a D-positive fetus. It is the most common immune antibody found in human serum. D-negative blood must be used for transfusion.

**TECHNICAL:** Anti-D is usually IgG and reacts best by the antiglobulin test and by enzyme techniques. In common with other antibodies in this blood group system, IgG anti-D does not activate the complement cascade. Some antisera contain an IgM component which causes direct agglutination of D-positive red cells. About 85% of random bloods are D-positive. The D antigen has a mosaic structure with at least 35 components. On rare occasions D-positive people who lack a component of the mosaic make anti-D directed against the component they lack. Such people should be transfused with D-negative blood.

### ***Anti-C***

**CLINICAL:** While anti-C on its own is uncommon it is frequently found in a mixture of anti-C+D. Some anti-C antibodies cause destruction of transfused C-positive red cells, and C-

negative blood should be used for transfusion. Anti-C+D is sometimes responsible for severe HDN.

**TECHNICAL:** Anti-C is usually an immune IgG antibody, but some IgM examples appear to be naturally occurring. About 30% of sera containing anti-D also contain anti-C (or a similar Rh antibody called anti-G). About 33% of random bloods and 73% of blood from blacks are C-negative and the majority of D-negative bloods are also C-negative. Anti-C reacts by antiglobulin and enzyme techniques but sera containing IgM antibody usually cause direct agglutination of C-positive red cells.

### ***Anti-C<sup>w</sup>***

**CLINICAL:** Anti-C<sup>w</sup> is a rare cause of hemolytic transfusion reactions or HDN. The C<sup>w</sup> antigen is an uncommon variant associated with C in the Rh system, and occurs in about 2% of unselected people. C<sup>w</sup>-negative blood should be used for transfusion to people with the antibody.

**TECHNICAL:** Anti-C<sup>w</sup> is usually an IgG antibody that reacts by antiglobulin and enzyme techniques. Some examples of the antibody are IgM and directly agglutinate C<sup>w</sup>-positive red cells. Anti-C<sup>w</sup> may (appear to) be naturally-occurring.

### ***Anti-E***

**CLINICAL:** Anti-E is a fairly common immune antibody that may cause hemolytic transfusion reactions or may be a rare cause of HDN. Transfusion should be made with E-negative blood.

**TECHNICAL:** Anti-E is usually an IgG antibody reactive by antiglobulin or enzyme techniques.

Some examples have an IgM component that causes direct agglutination of E-positive red cells.

About 62% of random D-positive bloods are E-negative, but nearly all D-negative red cell samples are also E-negative. Examples of anti-E are often found in a mixture with anti-c. When testing patients with anti-E who are c-negative, the possibility that anti-c is present in addition to anti-E must be excluded. Many examples of anti-E appear to be naturally-occurring.

### ***Anti-c***

**CLINICAL:** Anti-c is one of the most common immune antibodies found in D-positive people.

It may cause severe hemolytic transfusion reactions or severe HDN. Blood that is c-negative must be used for transfusion.

**TECHNICAL:** Anti-c is usually IgG and reacts by antiglobulin or enzyme techniques. About 17% of random donors are c-negative; almost all D-negative people are c-positive. Anti-c plus anti-E is a common antibody mixture. However, the majority of c-negative bloods are also E-negative (D<sup>Ce</sup>/D<sup>Ce</sup>) and an anti-E component will not add to the problem of finding compatible blood.

### ***Anti-e***

**CLINICAL:** Alloanti-e is an uncommon antibody, but may cause a hemolytic transfusion reaction or HDN. Red cells that are e-negative must be used for transfusion. Anti-e is also the most common specificity among specific IgG autoantibodies causing autoimmune hemolytic anemia.

**TECHNICAL:** Anti-e is always immune and reacts by antiglobulin or enzyme techniques.

About 3 in a 100 random bloods are e-negative. Almost all D-negative bloods will be e-positive.

Alloanti-e-like antibodies may be made by people with e + RBCs that lack some component of e.

### ***Anti-Ce***

**CLINICAL:** Anti-Ce (anti-rh<sub>i</sub>) may cause hemolytic transfusion reactions or HDN. Transfusion should be made with Ce-negative blood.

**TECHNICAL:** Anti-Ce is usually an IgG antibody reactive by antiglobulin and enzyme techniques. It reacts with a red cell antigen that is produced when *C* and *e* genes are in the cis position (i.e., on the same Rh chromosome). Anti-Ce will react with red cells having either R<sub>1</sub> or r' haplotypes. If an apparent alloanti-Ce is detected in a C+ or e+ Black individual, test the serum for the presence of the anti-e variant called anti-hr<sup>B</sup>.

### ***Anti-f***

**CLINICAL:** Anti-f is an uncommon antibody that may cause hemolytic transfusion reactions or HDN. Transfusion should be made with f-negative blood.

**TECHNICAL:** Anti-f is usually an IgG antibody reactive by antiglobulin and enzyme techniques. The antibody reacts with an antigen on red cells possessing the *ce* gene complex. However, it is not separable anti-c plus anti-e. All D-negative bloods and about 49% of D-positive bloods will be f-positive. Anti-f is unlikely to be available for donor screening but DCe/DCe or DcE/DcE blood will be compatible and can be selected for transfusion. If an

alloanti-f pattern of reactivity is obtained with serum from an f+ Black individual, test for the presence of anti-hr<sup>S</sup>. Anti-f frequently fade *in vivo* and *in vitro*.

### **Anti-G**

CLINICAL: Anti-G on its own is a rare antibody. Anti-G may cause severe hemolytic transfusion reactions or severe HDN. D-negative red cells are almost always G-negative and must be used for transfusion.

TECHNICAL: Anti-G is usually an IgG antibody reacting mainly by antiglobulin and enzyme methods. Some anti-C+D also contain anti-G. Nearly all D-positive or C-positive red cell samples are also G-positive. On very rare occasions a D-, C-, G+ cell sample may be found. About 14% of bloods are G-negative, all of them being D-negative.

### **Anti-V**

CLINICAL: Anti-V is an uncommon antibody that may cause a hemolytic transfusion reaction, but has not been reported as a cause of HDN. V-negative blood should be used for transfusion.

TECHNICAL: Anti-V is usually an IgG antibody reactive by antiglobulin and enzyme techniques. The V antigen is present on some red cell samples that have a *ce* gene complex. About 25% of Black donors and less than 0.01% of White donors are V-positive.

### **Anti-Rh17**

CLINICAL: Anti-Rh17 is a rare antibody that reacts with a high-incidence antigen. It is found in the serum of immunized individuals who are D- -. These rare people lack antigens that are

associated with the CcEe components of the Rh system. The antibody is usually potent and may cause severe hemolytic transfusion reactions or HDN. Compatible blood will be hard to find but must be used for transfusion.

**TECHNICAL:** Anti-Rh17 is usually IgG and reactive by the antiglobulin test and by enzyme techniques. Some examples of the antibody have a direct saline agglutinating component. Less than 1 in 50,000 donors will be D–, and lacking the Rh17 antigen. Siblings should be tested for compatibility and the patients urged to donate blood for long term cryogenic storage when their clinical state permits.

### ***Anti-Rh29***

**CLINICAL:** Anti-Rh29 is the immune antibody made by rare people of the Rh<sub>null</sub> type. These individuals lack all recognizable antigens of the Rh complex. The antibody is usually potent and may cause transfusion reactions or HDN. Transfusion is a major problem, for only Rh<sub>null</sub> blood is compatible.

**TECHNICAL:** Anti-Rh29 is IgG and reactive by the antiglobulin test and by enzyme techniques. If red cells from a patient with an antibody to a high-incidence antigen are non-reactive with all Rh typing sera, the Rh<sub>null</sub> phenotype, with anti-Rh29 in the serum, is the likely explanation. Siblings of these patients should be tested for compatibility, and the patients urged to donate blood for long term storage when their clinical state permits.

***Anti-hr<sup>S</sup>***

CLINICAL: Anti-hr<sup>S</sup> is an immune antibody that reacts with a high-incidence Rh antigen. The antibody may cause severe transfusion reactions. Compatible red cells must be transfused.

TECHNICAL: Anti-hr<sup>S</sup> is usually IgG and reacts by the antiglobulin test and by enzyme techniques. It usually presents as an apparent alloanti-e in an e+ person and may react with a pattern resembling anti-f. Most hr<sup>S</sup>-negative individuals are Black. Compatible blood is unlikely to be found by screening red cells from White donors. Siblings of the patient should be tested for compatibility, and the patients urged to donate blood for long term storage when their clinical stated permits. If there is no reactivity with E+ RBCs, R<sub>2</sub>R<sub>2</sub> blood can be used for transfusion.

***Anti-hr<sup>B</sup>***

CLINICAL: Anti-hr<sup>B</sup> is an immune antibody that reacts with a high-incidence Rh antigen. The antibody may cause severe transfusion reactions.

TECHNICAL: Anti-hr<sup>B</sup> is usually IgG and reacts by the antiglobulin test and by enzyme techniques. It usually presents as an apparent alloanti-e in an e+ person and may react with a pattern resembling anti-Ce. Most hr<sup>B</sup>-negative individuals are Black; compatible blood is unlikely to be found among bloods from White donors. Siblings of the patient should be tested for compatibility, and the patient urged to donate blood for long term storage when their clinical stated permits.

### ***Antibodies to Low-Incidence Antigens in the Rh Blood Group System***

CLINICAL: Antibodies have been found that define low-incidence antigens in the Rh system and are named: C<sup>x</sup>, E<sup>w</sup>, VS, D<sup>w</sup>, hr<sup>H</sup>, Go<sup>a</sup>, Rh32, Rh33, Rh35, Be<sup>a</sup>, Evans, Tar, Rh42, Rh43 (Crawford), Riv, JAL, STEM, BARC, FPTT, Rh42, Rh43. These antigens are well developed on the red cells of newborn babies of positive phenotype, and the antibodies can be a rare cause of severe HDN. Almost all random donors will be compatible and there is no difficulty in finding compatible blood for transfusion.

TECHNICAL: Antibodies to these low-incidence antigens are IgG and reactive by the antiglobulin test and by enzyme techniques.

## **LUTHERAN BLOOD GROUP SYSTEM**

### ***Anti-Lu<sup>a</sup>***

CLINICAL: Anti-Lu<sup>a</sup> has not been implicated in hemolytic transfusion reactions and only rarely been the cause of mild HDN. Weak examples of the antibody can be ignored for clinical purposes. Since the antigen has a frequency of only about 8% in the random population donor blood units that are incompatible with strong examples of the antibody should be avoided as an easy precaution against any unlikely complication.

TECHNICAL: Anti-Lu<sup>a</sup> is usually IgG and reactive by the antiglobulin test, but may directly agglutinate Lu(a+) red cells. Agglutination by this antibody, when examined microscopically, has a characteristic appearance, of mixed field type agglutination, with large stringy agglutinates in a background of unagglutinated cells.

### ***Anti-Lu<sup>b</sup>***

CLINICAL: Anti-Lu<sup>b</sup> reacts with a common red cell antigen. It can cause mild hemolytic transfusion reactions and has also been implicated as a rare cause of mild HDN. Lu(b-) blood should be used for transfusion.

TECHNICAL: Anti-Lu<sup>b</sup> usually reacts by the antiglobulin test. Only about 1 in 500 donors will be Lu(b-), and it is important to test for compatible siblings and to encourage patients to donate blood for long term storage when their clinical state permits.

### ***Anti-Lu3***

CLINICAL: Anti-Lu3 reacts with a common red cell antigen. It is found in the serum of immunized people of the rare recessive Lu(a-b-) type. It may cause a delayed hemolytic transfusion reaction or HDN. Rare donor blood of dominant or recessive inheritance Lu(a-b-) type should be used for transfusion.

TECHNICAL: Anti-Lu3 is usually IgG and reactive by the antiglobulin test. Siblings of the patient should be tested for compatibility, and patients encouraged to donate blood for long term storage when their clinical state permits.

## ***Antibodies to High-Incidence Antigens in the Lutheran Blood Group***

### ***System***

CLINICAL: A series of high-incidence antigens related to the Lutheran blood group system have been identified and named: Lu4, Lu5, Lu6, Lu7, Lu8, Lu11, Lu12, Lu13, Lu16, Lu17, and Lu20.

Most random donor units are incompatible with antibodies directed at these antigens but the

antibodies are weak and do not usually cause hemolytic transfusion reactions. HDN has not been reported. In a rare exception, one example of anti-Lu6 was shown to destroy transfused Lu6 red cells. It is recommended that as a precaution dominant inheritance Lu(a-b-) blood should be used for transfusion to patients with strong antibodies to these high incidence antigens in the Lutheran system.

**TECHNICAL:** These antibodies are usually IgG, weak, and reactive by the antiglobulin test against most random blood samples. Red cells from newborns react less strongly than cells from adults. Siblings should be tested for compatibility, and patients encouraged to donate blood for long term storage when their clinical state permits.

### ***Antibodies to Low-Incidence Antigens in the Lutheran Blood Group System***

**CLINICAL:** Anti-Lu9 and anti-Lu14 define rare antigens. The antibodies have not been reported as a cause of transfusion reactions but one example of HDN, caused by anti-Lu14 is reported.

Most random bloods will be antigen-negative and compatible.

**TECHNICAL:** Anti-Lu9 and anti-Lu14 are IgG reactive by the antiglobulin test. They define low-incidence antigens that are antithetical to the common Lutheran antigens Lu6 and Lu8, respectively.

## **KELL BLOOD GROUP SYSTEM**

### ***Anti-K***

**CLINICAL:** Anti-K may cause hemolytic transfusion reactions if K-positive red cells are transfused, or severe HDN in K-positive newborns. K-negative blood must be used for transfusion.

**TECHNICAL:** Anti-K is usually IgG and reactive by the antiglobulin test. The antibody may be potent. A minority of antisera may contain an IgM saline agglutinating component. About 91% of donors are K-negative and compatible blood is easy to find by random screening. The antibody may not react well by LISS procedures and it is recommended that compatibility tests should be made using an indirect antiglobulin procedure with saline suspended red cells. In common with all Kell blood group antibodies anti-K does not react with AET-, DTT- or ZZAP-treated antigen-positive red cells.

### ***Anti-k***

**CLINICAL:** Anti-k can cause hemolytic reactions to the transfusion of antigen positive red cells, and on rare occasions HDN. Blood of k-negative type must be used for transfusion.

**TECHNICAL:** Anti-k is an uncommon IgG antibody that reacts by the antiglobulin test with an antigen that is antithetical to K. About 1 in 500 random blood donors will be k-negative.

### ***Anti-Kp<sup>a</sup>***

CLINICAL: On rare occasions anti-Kp<sup>a</sup> has caused a mild hemolytic transfusion reaction or mild to moderate HDN. Kp(a–) blood should be used for transfusion.

TECHNICAL: The antibody is usually IgG and reactive by the antiglobulin test. About 2% of random individuals are Kp(a+).

### ***Anti-Kp<sup>b</sup>***

CLINICAL: Anti-Kp<sup>b</sup> reacts with a high incidence antigen that is antithetical to Kp<sup>a</sup>. The antibody can cause hemolytic reactions to blood transfusion and, on rare occasions, HDN. Rare blood of Kp(b–) type should be used for transfusion.

TECHNICAL: Anti-Kp<sup>b</sup> is usually IgG and reactive by the antiglobulin test. As only about 1 in 5000 donors will be Kp(b–), attempts to find compatible blood by screening random donor units are unlikely to be successful. The antibody does not react with AET-, DTT- or ZZAP-treated red cells, which may help in recognizing the Kell- related specificity of the antibody. Siblings should be tested for compatibility, and patients encouraged to donate blood for long term storage when their clinical state permits.

### ***Anti-Js<sup>a</sup>***

CLINICAL: Anti-Js<sup>a</sup> may be a rare cause of a hemolytic transfusion reaction or HDN. Js(a–) blood should be used for transfusion.

TECHNICAL: Anti-Js<sup>a</sup> is usually IgG and reacts by the antiglobulin test. The Js<sup>a</sup> antigen is present on the red cells of about 20% of Blacks and less than 0.01% of Whites.

***Anti-Js<sup>b</sup>***

CLINICAL: Anti-Js<sup>b</sup> is an immune antibody that reacts with a high-incidence red cell antigen that is antithetical to Js<sup>a</sup>. The antibody may cause severe transfusion reactions or HDN. Js(b–) blood must be used for transfusion.

TECHNICAL: Anti-Js<sup>b</sup> is usually IgG, and reactive by the antiglobulin test. It is non-reactive with red cells treated with AET, DTT or ZZAP. Red cells from all Whites are Js(b+), but about 1 in 100 Blacks is Js(b–). Siblings should be tested for compatibility, and the patients encouraged to donate blood for long term storage when their clinical state permits.

***Anti-Ku***

CLINICAL: Anti-Ku is a rare immune antibody that reacts with a common antigen in the Kell system which is present on all red cell samples except those of the rare K<sub>0</sub> or K<sub>mod</sub> types. The antibody can cause hemolytic transfusion reactions or HDN. K<sub>0</sub> red cells must be used for transfusion.

TECHNICAL: Anti-Ku is usually IgG and reactive by the antiglobulin test. The antibody is produced by K<sub>0</sub> and K<sub>mod</sub> individuals and less than 1 in 50,000 donors will be compatible. It is important to test siblings of any K<sub>0</sub> patient in a quest for compatible blood, and to encourage patients to donate blood for long term storage when their clinical state permits. As with other Kell system antibodies, anti-Ku is non-reactive with antigen-positive red cells that have been treated with AET, DTT or ZZAP.

***Antibodies to High-Incidence Antigens in the Kell Blood Group System***

CLINICAL: A series of high-incidence antigens have been found that are part of the Kell blood group system. They have been named K11, K12, K13, K14, K18, K19, K20, K22, and K26.

Rare individuals who lack one of these antigens may become immunized to it. Compatible donors are rare, but in some cases transfusion of incompatible red cells has been well tolerated.

K<sub>0</sub> (K<sub>null</sub>) blood is compatible with all antibodies in this series, but because of its great rarity should be reserved for transfusion to cases in which there is evidence that the antibody may have clinical significance. HDN caused by antibodies in this series, though rare, has been reported for anti-K11, -K14 and K22.

TECHNICAL: These antibodies are almost always IgG and active by the antiglobulin test. All random donor and panel red cell samples will be reactive, but the antibodies do not react with AET-, DTT- or ZZAP-treated cells. The antigens are well developed on the red cells of newborns.

***Antibodies to Low-Incidence Antigens in the Kell Blood Group System***

CLINICAL: Antibodies have been found that define low-incidence antigens in the Kell system.

K10, K17, K21, K23, K24 and K25 all have an incidence of less than 0.001 in the random population. The antigens are well developed in infants of positive phenotype at birth, and on rare occasions an antibody in this series has caused HDN. Almost all random donors will be compatible and there is no difficulty in finding blood for transfusion.

TECHNICAL: Antibodies to these low-incidence antigens have all been IgG and reactive by the antiglobulin test. Very rarely they may be encountered during routine compatibility testing when red cells from a random donor are unexpectedly found to be incompatible.

## LEWIS BLOOD GROUP SYSTEM

### ***Anti-Le<sup>a</sup>***

CLINICAL: Anti-Le<sup>a</sup> is a common naturally-occurring antibody in the serum of Le(a-b-) people. Most examples of the antibody have no clinical significance. Rare examples, that have activity at 37EC, may cause a hemolytic reaction if Le(a+) red cells are given. Patients with anti-Le<sup>a</sup> active at 37EC should be transfused with Le(a-) blood. The Le<sup>a</sup> antigen is not developed on the red cells of newborn infants and the antibody does not cause HDN. Le<sup>a</sup> and Le<sup>b</sup> are plasma antigens passively adsorbed onto the red cells.

TECHNICAL: Anti-Le<sup>a</sup> may be a direct agglutinin and can also react by the antiglobulin test. It is enhanced by using enzyme techniques and may cause complement-mediated hemolysis of Le(a+) red cells at 37EC. Anti-Le<sup>a</sup> can be neutralized/inhibited in the test tube using commercial Lewis substance or saliva. Anti-Le<sup>a</sup> is often found in association with anti-Le<sup>b</sup>. The antibody is found more commonly in sera from Black people, among whom the incidence of the Le(a-b-) type is higher. About 78% of random blood samples from Whites are Le(a-).

**Anti-Le<sup>b</sup>**

CLINICAL: Anti-Le<sup>b</sup> is a naturally-occurring antibody found most frequently in Black people, among whom the incidence of the Le(a-b-) type is highest. The Le<sup>b</sup> antigen is not developed on red cells from newborns. Although the antibody may be active at 37EC it does not cause hemolytic transfusion reactions or HDN, and may be ignored for clinical purposes.

TECHNICAL: Anti-Le<sup>b</sup> is usually a cold agglutinin. It often shows enhanced activity against enzyme-treated antigen-positive red cells. Rare examples of the antibody may show activity at 37EC, and cause hemolysis of Le(b+) test red cells. Anti-Le<sup>b</sup> is inhibited by Le(b+) plasma, both in the test tube and in the circulation. Similarly, saliva or commercial Lewis substance will also inhibit anti Le<sup>b</sup> in the test tube and can aid the antibody identification process. About 75% of Whites are Le(b+). It is not necessary to select Le(b-) blood for transfusion.

**Anti-Le<sup>x</sup>**

CLINICAL: Anti-Le<sup>x</sup> is an uncommon naturally-occurring antibody in the serum of some Le(a-b-) people. Most examples of the antibody are benign and have no clinical significance. Rare examples of the antibody that are active at 37EC may cause a hemolytic transfusion reaction. It is recommended that blood transfused to patients with antibody active at 37EC should be Le(a-b-). Although the Le<sup>x</sup> antigen is developed at birth the antibody has not been implicated in HDN.

TECHNICAL: Anti-Le<sup>x</sup> reacts with all red cell samples except those of Le(a-b-) type, but does not appear to be a mixture of anti-Le<sup>a</sup> and anti-Le<sup>b</sup>. The antibody also reacts with red cells from many cord blood samples. Red cells of 6% of Whites and at least 23% of Blacks are Le(a-b-).

## DUFFY BLOOD GROUP SYSTEM

### ***Anti-Fy<sup>a</sup>***

CLINICAL: Anti-Fy<sup>a</sup> is a not uncommon immune antibody that may cause a hemolytic transfusion reaction. It is a rare cause of mild or severe HDN. Red cells that are Fy(a–) should be used for transfusion.

TECHNICAL: Anti-Fy<sup>a</sup> is nearly always an IgG antibody reactive only by the antiglobulin test.. About 34% of Whites are Fy(a–). Nearly 70% of Blacks are Fy(a–b–) and these donors are a source of compatible blood and blood that is particularly useful in solving antibody problems involving the Duffy blood group.

### ***Anti-Fy<sup>b</sup>***

CLINICAL: Anti-Fy<sup>b</sup> is an uncommon immune antibody. On rare occasions it has caused mild to severe hemolytic transfusion reaction, and occasionally has caused mild HDN. Donor blood that is Fy(b–) should be used for transfusion.

TECHNICAL: Anti-Fy<sup>b</sup> is nearly always an IgG antibody reactive only by the antiglobulin test. The Fy<sup>b</sup> antigen seems to have low immunogenicity and when found the antibody is usually in a multi-transfused patient who has already made other blood group antibodies. The Fy<sup>b</sup> antigen is denatured by papain or ficin. About 20% of Whites and almost 80% of Blacks are Fy(b–). Among Blacks nearly 70% are Fy(a–b–); these donors are particularly useful as a source of compatible blood for patients immunized to Fy<sup>a</sup> or Fy<sup>b</sup> antigens.

### ***Anti-Fy3***

CLINICAL: Anti-Fy3 is a rare antibody made by some individuals of Fy(a–b–) type. Little clinical information is available, but the antibody has caused mild to moderate hemolytic reactions to the transfusion of incompatible red cells and, rarely, mild HDN.

TECHNICAL: Anti-Fy3 is usually IgG and reactive by the antiglobulin test. The antibody reacts with all Fy(a+) or Fy(b+) red cells, but does not appear to be a mixture of anti-Fy<sup>a</sup> and anti-Fy<sup>b</sup>.

Unlike other Duffy antigens, the Fy3 antigen is not denatured by proteolytic enzymes.

Compatible blood of Fy(a–b–) type will be readily found among Black donors. The Fy(a-b-) type is also found in some Israeli and Arabian populations.

## **KIDD BLOOD GROUP SYSTEM**

### ***Anti-Jk<sup>a</sup>***

CLINICAL: Anti-Jk<sup>a</sup> is one of the most dangerous immune antibodies that may occur in human serum. The antibody may cause severe immediate or delayed hemolytic transfusion reactions or, on rare occasions, HDN. Jk(a–) blood must be used for transfusion.

TECHNICAL: Anti-Jk<sup>a</sup> reacts best by antiglobulin technique with a polyspecific anti-human globulin reagent. The antibody usually binds complement. Some examples may cause weak hemolysis, or weak direct agglutination, of enzyme-treated Jk(a+) red cells. About 23% of random bloods are Jk(a–). Current technical methods may not have good sensitivity for all anti-Jk<sup>a</sup> antibodies and, not uncommonly, apparent weak anti-Jk<sup>a</sup> may cause a brisk hemolytic reaction if incompatible red cells are transfused. Anti-Jk<sup>a</sup> fades *in vitro* and *in vivo*.

**Anti-Jk<sup>b</sup>**

CLINICAL: Anti-Jk<sup>b</sup> is an immune antibody that may cause immediate or delayed hemolytic transfusion reactions. Jk(b–) blood must be used for transfusion. The antibody has rarely been reported as a mild cause of HDN.

TECHNICAL: Anti-Jk<sup>b</sup> is usually IgG, may bind complement, and is best detected by the antiglobulin test using a polyspecific antiglobulin reagent. About 26% of random donors are Jk(b–).

**Anti-Jk3**

CLINICAL: Anti-Jk3 reacts with a high-incidence antigen present on all red cell samples except those of Jk(a–b–) type. It is an immune antibody that may cause immediate or delayed hemolytic transfusion reactions or mild HDN. Red cells of the rare Jk(a–b–) type must be used for transfusion. Anti-Jk<sup>b</sup> fades *in vitro* and *in vivo*.

TECHNICAL: Anti-Jk3 is nearly always an IgG antibody best detected by the antiglobulin test using a polyspecific antiglobulin reagent. The antibody is monospecific and is not a mixture of anti-Jk<sup>a</sup> and anti-Jk<sup>b</sup>. Red cells from individuals producing anti-Jk3 type as Jk(a–b–). Cells of this phenotype may also be recognized by their resistance to lysis by aqueous 2M urea solutions. The Jk(a–b–) phenotype is extremely rare in Black and White populations but is not uncommon among Polyensians. It is important to test siblings of any immunized Jk(a–b–) patient for compatibility, and to urge the patient to donate blood for long term storage when the clinical state permits.

## **DIEGO BLOOD GROUP SYSTEM**

### ***Anti-Di<sup>a</sup>***

CLINICAL: Anti-Di<sup>a</sup> detects a rare red cell antigen that occurs mainly in South American Indians (up to 36% Di(a+), Native Americans and other Mongoloid people. Anti-Di<sup>a</sup> may cause destruction of transfused Di(a+) red cells, or HDN in a Di(a+) infant. Nearly all donor bloods will be Di(a-) and compatible.

TECHNICAL: Anti-Di<sup>a</sup> is usually IgG and reactive by the antiglobulin test.

### ***Anti-Di<sup>b</sup>***

CLINICAL: Anti-Di<sup>b</sup> is a rare antibody that reacts with a common red cell antigen that is antithetical to Di<sup>a</sup>. The antibody may cause red cell destruction of transfused Di(b+) red cells, or HDN.

TECHNICAL: Anti-Di<sup>b</sup> is usually IgG and reactive by the antiglobulin test. Almost all Di(b-) bloods have been found in South American Indians, Native Americans and people of Mongoloid extraction. It is important to test siblings of immunized Di(b-) patients for compatibility and to urge the patients to donate blood for long term storage when their clinical state permits.

### ***Anti-Wr<sup>a</sup>***

CLINICAL: Anti-Wr<sup>a</sup> reacts with a rare red cell antigen, and is a very uncommon cause of a hemolytic transfusion reaction or HDN. Compatible blood is easily found by screening random donor units.

TECHNICAL: Anti-Wr<sup>a</sup> may be either IgM or IgG and is usually naturally occurring. The antibody is not uncommon, particularly in patients with warm antibody autoimmune hemolytic anemia. However, Wr(a+) individuals have a frequency of less than 0.1%.

### ***Antibodies to Low Incidence Antigens in the Diego Blood Group System***

CLINICAL: Antibodies that define low incidence antigens in the Diego blood group system are: Wd<sup>a</sup>, Rb<sup>a</sup>, WARR, ELO, Wu, Bp<sup>a</sup>, Mo<sup>a</sup>, Hg<sup>a</sup>, Vg<sup>a</sup>, Sw<sup>a</sup>, BOW, NFLD, Jn<sup>a</sup>, KREP, Tr<sup>a</sup>, Fr<sup>a</sup> and SWI. These antigens are well developed on red cells from newborn infants of positive phenotype and the antibodies may cause HDN. Almost all random donors will be compatible and there is no difficulty in finding blood for transfusion.

TECHNICAL: Antibodies to those low-incidence antigens may be IgG or IgM and are often found in sera containing multiple antibodies low-incidence antigens.

## **YT BLOOD GROUP SYSTEM**

Yt antigens are carried on acetylcholinesterase.

### ***Anti-Yt<sup>a</sup>***

CLINICAL: Anti-Yt<sup>a</sup> reacts with a common red cell antigen. In most cases the antibody is benign and will not cause clinical problems if Yt(a+) red cells are transfused. A few cases are known in which anti-Yt<sup>a</sup> has caused accelerated destruction of transfused Yt(a+) red cells. Anti-Yt<sup>a</sup> is not known to cause HDN.

TECHNICAL: Anti-Yt<sup>a</sup> is usually IgG and reactive by the antiglobulin test. About 1 in 500 donors is Yt(a-).

### ***Anti-Yt<sup>b</sup>***

CLINICAL: Anti-Yt<sup>b</sup> is a rare antibody reacting with an uncommon antigen that is antithetical to Yt<sup>a</sup>. The antibody has not been implicated in hemolytic transfusion reactions or HDN. However, the great majority of donors are Yt(b-) and compatible.

TECHNICAL: Anti-Yt<sup>b</sup> is usually IgG and reactive by the antiglobulin test. About 8% of random donors are Yt(b+) but up to 20% of the Israeli population is Yt(b+). Since compatible blood can be found easily by screening random donor units these should be selected for transfusion.

## **Xg BLOOD GROUP SYSTEM**

### ***Anti-Xg<sup>a</sup>***

CLINICAL: Anti-Xg<sup>a</sup> is an uncommon immune antibody and can be apparently naturally occurring. The antibody has not been implicated in hemolytic transfusion reactions nor HDN. Anti-Xg<sup>a</sup> is not available as a commercial red cell typing reagent and transfusion should be made with crossmatch-compatible blood.

TECHNICAL: Anti-Xg<sup>a</sup> is usually an IgG antibody reactive only by the antiglobulin test. The Xg<sup>a</sup> antigen has low immunogenicity and anti-Xg<sup>a</sup> is usually a weak antibody. The Xg<sup>a</sup> antigen is

denatured by papain or ficin. The  $Xg^a$  gene is carried on the X chromosome. About 34% of random males and 11% of females are  $Xg(a-)$ .

## **SCIANNA BLOOD GROUP SYSTEM (ISBT 013)**

### ***Anti-Sc1***

**CLINICAL:** Anti-Sc1 defines a high-incidence antigen. The antibody is rare and appears to be immune. It is not known to cause clinical transfusion problems or HDN.

**TECHNICAL:** Anti-Sc1 is a rare IgG antibody reactive by the antiglobulin test. Siblings of patients making the antibody should be tested for compatibility, and patients encouraged to donate blood for long term storage when their clinical condition permits.

### ***Anti-Sc2***

**CLINICAL:** Anti-Sc2 identifies a rare red cell antigen that is antithetical to Sc1. The antibody is not known to cause problems in clinical transfusion, but has caused mild HDN on rare occasions.

Since the Sc2 antigen has a low-incidence, the great majority of donor blood samples will be compatible.

**TECHNICAL:** Anti-Sc2 is usually IgG and reactive by the antiglobulin test. About 1 percent of random donor red cell samples are Sc2+.

## DOMBROCK BLOOD GROUP SYSTEM

### ***Anti-Do<sup>a</sup>***

CLINICAL: Anti-Do<sup>a</sup> is an uncommon immune antibody. On rare occasions it has caused an acute hemolytic transfusion reaction, or mild HDN. Do(a–) blood, found by screening random donor blood samples, should be used for transfusion.

TECHNICAL: Anti-Do<sup>a</sup> is usually an IgG antibody that reacts best by the antiglobulin test using red cells that have been enzyme-treated. The antibody shows considerable variation in reaction strength against different Do(a+) cell samples. About 66% of Whites are Do(a+), but the incidence is lower in Black people.

### ***Anti-Do<sup>b</sup>***

CLINICAL: Anti-Do<sup>b</sup> is an uncommon immune antibody. Rare examples have caused mild transfusion reactions but HDN has not been reported.

TECHNICAL: Anti-Do<sup>b</sup> is usually an IgG antibody that reacts best by the antiglobulin test using red cells that have been enzyme-treated. The antibody shows variation in reaction strength against different Do(b+) cell samples. 17% of random donors are Do(b–).

### ***Anti-Gy<sup>a</sup>***

CLINICAL: Anti-Gy<sup>a</sup> reacts with a high incidence red cell antigen. The antibody may cause in vivo destruction of Gy(a+) red cells, or mild HDN. Gy(a–) blood should be used for transfusion.

**TECHNICAL:** Anti-Gy<sup>a</sup> is usually IgG and reactive by the antiglobulin test. Siblings of immunized Gy(a–) patients should be tested for compatibility and Gy(a–) patients urged to donate blood for long term storage when their clinical state permits. Gy(a–) red cells are Gy(a–), Hy–, Jo(a–), and Do(a–b–). All people of such phenotype have been White.

### ***Anti-Hy***

**CLINICAL:** Anti-Hy is a rare antibody that reacts with a high incidence red cell antigen. The antibody may cause in vivo destruction of Hy-positive red cells, or mild HDN. Hy-negative blood should be used for transfusion.

**TECHNICAL:** Anti-Hy is nearly always IgG and reactive by the antiglobulin test. The Hy-negative blood type is rare and has been found only among Black people. Siblings of immunized Hy-negative patients should be tested for compatibility, and Hy-negative patients urged to donate blood for long term storage when their clinical state permits. Hy-negative red cells are Jo(a–), Gy(a weak), Do(a-b weak).

### ***Anti-Jo<sup>a</sup>***

**CLINICAL:** Anti-Jo<sup>a</sup> is a rare antibody that reacts with a high incidence red cell antigen. It may cause destruction of transfused Jo(a+) red cells, but has not caused HDN. Jo(a–) blood should be used for transfusion.

**TECHNICAL:** The Jo(a–) blood type has an incidence of less than 1 in 4000 and all people of such phenotype have been Black. Anti-Jo<sup>a</sup> is usually IgG and reactive only by the antiglobulin

test. Siblings of immunized Jo(a–) patients should be tested for compatibility, and Jo(a–) patients urged to donate blood for long term storage when their clinical state permits.

## COLTON BLOOD GROUP SYSTEM

### ***Anti-Co<sup>a</sup>***

CLINICAL: Anti-Co<sup>a</sup> is a rare antibody that reacts with a common red cell antigen. The antibody may cause in vivo destruction of Co(a+) red cells, or HDN.

TECHNICAL: Anti-Co<sup>a</sup> is usually IgG and reactive by the antiglobulin test and by enzyme techniques. Siblings of the Co(a–) patient should be tested for compatibility, and immunized patients urged to donate blood for long term storage when their clinical state permits.

### ***Anti-Co<sup>b</sup>***

CLINICAL: Anti-Co<sup>b</sup> is a rare antibody that reacts with an antigen having an incidence of approximately 10% in the general population. It may cause destruction of transfused Co(b+) red cells and antigen negative blood should be used for transfusion. Mild HDN caused by anti-Co<sup>b</sup> has been reported.

TECHNICAL: Anti-Co<sup>b</sup> is usually IgG and reactive by the antiglobulin test and by enzyme techniques. As the majority of individuals are Co(b–) compatible blood can be easily found by screening random donors.

## LANDSTEINER-WIENER BLOOD GROUP SYSTEM

### ***Anti-LW<sup>a</sup>***

**CLINICAL:** Anti-LW<sup>a</sup> is an uncommon immune antibody reacting against a high-incidence red cell antigen. It may cause a mild hemolytic reaction to a transfusion of LW(a+) red cells, or mild HDN. Because of its rarity, LW(a–) blood is not likely to be available for transfusion. D-negative blood should be transfused since these red cells have less LW<sup>a</sup> antigen than D-positive cells. Such transfusions are usually well tolerated.

**TECHNICAL:** Anti-LW<sup>a</sup> is usually IgG and reacts best by antiglobulin and enzyme techniques. As the antibody reacts more strongly with D-positive red cells than with D-negative cells it is sometimes mistaken for anti-D. However, D-negative red cells react weakly with anti-LW<sup>a</sup>, and in addition LW<sup>a</sup> antigen on red cells is destroyed by treatment with DTT or pronase, while D antigen is not. On rare occasions, and usually in association with pregnancy, the red cells of LW(a+) people become temporarily LW(a–), and the individuals make anti-LW<sup>a</sup> or anti-LW<sup>ab</sup>.

### ***Anti-LW<sup>b</sup>***

**CLINICAL:** Anti-LW<sup>b</sup> reacts with a rare blood group antigen. The antibody is usually immune and has the potential to cause hemolysis of transfused incompatible red cells, or HDN. Red cells from the majority of individuals are LW(b–) and compatible blood is easily found by screening random donor units.

**TECHNICAL:** Anti-LW<sup>b</sup> is usually IgG and reactive by the antiglobulin test.

## **CHIDO/RODGERS BLOOD GROUP SYSTEM**

### ***Anti-Ch***

**CLINICAL:** Anti-Ch is a benign nebulous antibody that reacts with a common red cell antigen.

The antibody does not cause transfusion reactions or HDN, and should be ignored for clinical purposes.

**TECHNICAL:** Anti-Ch is usually reactive by the antiglobulin test, with considerable variation in reaction strength given by different cell samples. Ch is a marker on the C4d component of complement, which becomes attached to red cells in the circulation. Anti-Ch is neutralized in the test tube or in the circulation by plasma from a Ch-positive person, and is non-reactive with enzyme-treated red cells. About 96% of random individuals are Ch-positive.

### ***Anti-Rg***

**CLINICAL:** Anti-Rg is a benign nebulous antibody that reacts with a common red cell antigen.

The antibody does not cause transfusion reactions or HDN and should be ignored for clinical purposes.

**TECHNICAL:** Anti-Rg is usually an IgG antibody reactive by the antiglobulin test, with considerable variation in reaction strength given by different cell samples. Since Rg is a marker on the C4d component of complement, anti-Rg is neutralized by plasma containing C4 from a Rg-positive person. Anti-Rg is non-reactive with enzyme-treated red cells. About 98% of donors are Rg-positive.

## Hh BLOOD GROUP SYSTEM

**CLINICAL:** Anti-H is almost always a naturally-occurring cold-reactive antibody found in the serum of some group A<sub>1</sub> or A<sub>1</sub>B people. It does not cause hemolytic transfusion reactions or HDN. In this circumstance red cells of homologous ABO type can be used for transfusion. An exception to this occurs with the powerful anti-H found in the serum of rare people of the O<sub>h</sub> (Bombay) phenotype. These individuals lack red cell A, B, and H antigens, have strong anti-H (together with anti-A and anti-B) that is active at 37°C, and must be transfused with O<sub>h</sub> red cells.

**TECHNICAL:** Naturally-occurring anti-H is an uncommon IgM antibody that causes direct agglutination of reactive red cells. H antigen strength of cells varies with their ABO blood type. Group O and A<sub>2</sub> cells react most strongly with anti-H, B cells are less reactive, and A<sub>1</sub> and A<sub>1</sub>B red cells have little, if any, reactivity. Red cells of newborns have weak H antigen. Anti-H can be neutralized in the test tube using H-blood group substance obtained from saliva of any group O, A, or B secretor, thereby differentiating it from the more common anti-IH or anti-I cold agglutinins found in human serum. Powerful anti-H present in the serum of O<sub>h</sub> individuals may have complement-dependent hemolytic activity. This antibody also can be inhibited in the test tube by saliva from an H secretor individual.

## Kx BLOOD GROUP SYSTEM

### ***Anti-Kx***

**CLINICAL:** Anti-Kx is a rare antibody related, at the phenotypic level, to the Kell blood group system. Because the Kx-negative (McLeod) phenotype is an X-borne inherited characteristic it

is carried by females but expressed only in males. Therefore, anti-Kx is made by immunized males who are of the McLeod red cell phenotype and also have X-linked chronic granulomatous disease. The antibody is usually immune and has the potential to destroy incompatible red cells. As the antibody is only made by males, the possibility of HDN does not arise.

**TECHNICAL:** Anti-Kx is IgG and active by the antiglobulin test. The Kx antigen is of high-incidence and only red cells of the rare McLeod blood group phenotype are compatible.

## **GERBICH BLOOD GROUP SYSTEM**

### ***Anti-Ge***

**CLINICAL:** Anti-Ge is a rare antibody that reacts with a high-incidence red cell antigen. It may be immune or naturally-occurring. While some examples of this antibody have caused destruction of transfused Ge<sup>+</sup> red cells, others are benign. HDN has not been reported.

**TECHNICAL:** Anti-Ge is usually IgG and reactive by the antiglobulin test. Some antisera may have an IgM component. Because Ge-negative donors are rare, it is important to test siblings of Ge-negative patients for compatibility, and to urge such individuals to donate blood for long term storage. At least 3 different Gerbich-negative variant phenotypes are known: Yus (Ge:–2,3,4), Gerbich (Ge:–2,–3,4) and Leach (Ge:–2,–3,–4). Ge<sub>2</sub> is denatured by ficin or papain; Ge<sub>3</sub> is usually weakened by these enzymes.

### ***Antibodies to Low-Incidence Antigens in the Gerbich Blood Group System***

CLINICAL: Antibodies to low-incidence antigens in the Ge blood group system (named Wb, Ls<sup>a</sup>, An<sup>a</sup>, and Dh<sup>a</sup>) have not caused HDN. Red cells from almost all random donors will be compatible and there is no difficulty in finding blood for transfusion.

TECHNICAL: Antibodies to these low-incidence antigens may be IgG or IgM, and may be naturally-occurring. They do not agglutinate enzyme-treated antigen-positive red cells.

## **CROMER BLOOD GROUP SYSTEM**

### ***Anti-Cr<sup>a</sup>***

CLINICAL: Anti-Cr<sup>a</sup> is a rare antibody that reacts with a high-incidence red cell antigen. The antibody may cause destruction of transfused Cr(a+) red cells; HDN has not been reported.

Cr(a-) blood should be used for transfusion.

TECHNICAL: Anti-Cr<sup>a</sup> reacts with an antigen present on most random red cell samples. The antibody is usually IgG and reactive by the antiglobulin test. It is important to check siblings of any Cr(a-) patient in the quest for compatible blood and to urge patients to donate blood for long term storage when their clinical state permits.

### ***Antibodies to high-Incidence Antigens in the Cromer Blood Group System***

CLINICAL: A series of high-incidence antigens have been found that are part of the Cromer blood group system: Tc<sup>a</sup>, Dr<sup>a</sup>, Es<sup>a</sup>, IFC WES<sup>b</sup>, UMC. Little is known about the clinical

significance of these antibodies but some examples have caused destruction of antigen-positive transfused red blood cells. They have not been implicated in HDN.

**TECHNICAL:** These antibodies are usually IgG and reactive by the antiglobulin test. They do not agglutinate, or only weakly agglutinate, AET-treated red cells. Siblings should be tested for compatibility and patients urged to donate blood for long term storage when their clinical state permits. The null type, called the INAB phenotype, will be compatible.

### ***Antibodies to Low-Incidence Antigens in the Cromer Blood Group System***

**CLINICAL:** A series of antibodies that define several low-incidence antigens in the Cromer blood group system have been described and named: Tc<sup>b</sup>, Tc<sup>c</sup>, WES<sup>a</sup> Clinical information is scarce but almost all donors will be compatible and there is no difficulty in finding blood for transfusion.

**TECHNICAL:** Antibodies to these low-incidence antigens are usually IgG and reactive by the antiglobulin test.

## **KNOPS BLOOD GROUP SYSTEM**

### ***Anti-Kn<sup>a</sup>***

**CLINICAL:** Anti-Kn<sup>a</sup> is a benign antibody that reacts with a common red cell antigen. The antibody does not cause hemolytic transfusion reactions or HDN and can be ignored for clinical purposes.

**TECHNICAL:** Anti-Kn<sup>a</sup> is an IgG antibody, reacting variably by the antiglobulin test. About 98% of donors are Kn(a+).

### ***Anti-McC<sup>a</sup>***

CLINICAL: Anti-McC<sup>a</sup> is a benign antibody that reacts with a common red cell antigen. The antibody does not cause transfusion reactions or HDN and can be ignored for clinical purposes.

TECHNICAL: Anti-McC<sup>a</sup> is an IgG antibody, reacting by the antiglobulin test with varied reaction strength against different cell samples. About 95% of donors are McC(a+).

### ***Anti-SI<sup>a</sup>***

CLINICAL: Anti-SI<sup>a</sup> is a benign antibody that reacts with a common red cell antigen. The antibody does not cause transfusion reactions or HDN, and can be ignored for clinical purposes.

TECHNICAL: Anti-SI<sup>a</sup> is an IgG antibody, reacting variably by the antiglobulin test. About 98% of random White donors and 60% of random Black donors are SI(a+).

### ***Anti-Yk<sup>a</sup>***

CLINICAL: Anti-Yk<sup>a</sup> is a benign antibody that reacts with a common red cell antigen. The antibody does not cause transfusion reactions or HDN and can be ignored for clinical purposes.

TECHNICAL: Anti-Yk<sup>a</sup> is usually IgG, reacting variably against different antigen positive red cell samples by the antiglobulin test. About 95% of donors are Yk(a+).

## INDIAN BLOOD GROUP SYSTEM

### ***Anti-In<sup>a</sup>***

CLINICAL: Anti-In<sup>a</sup> is a rare antibody, that can be naturally-occurring or immune, which recognizes a low-incidence red cell antigen. Decreased survival of transfused antigen-positive red cells has been reported, but there are not reports of HDN.

TECHNICAL: Anti-In<sup>a</sup> reacts with an antigen having an incidence of 3% in red cells from random individuals from India. The antibody can be IgM or IgG, agglutinating cells in saline, or by the antiglobulin test. Anti-In<sup>a</sup> does not agglutinate enzyme-treated, DTT-treated or AET-treated red cells.

### ***Anti-In<sup>b</sup>***

CLINICAL: Anti-In<sup>b</sup> is a rare antibody that reacts with a high-incidence red cell antigen that is antithetical to In<sup>a</sup>. Clinical information is scarce, but there have been reports of severe, delayed and hemolytic transfusion reactions.

TECHNICAL: Anti-In<sup>b</sup> can be direct agglutinins or IgG, reacts with a common red cell antigen and can agglutinate cells in saline, or by the antiglobulin test. Anti-In<sup>b</sup> does not agglutinate enzyme-treated, DTT-treated or AET-treated red cells. Sibs should be tested for compatibility and patients should be encouraged to donate blood for long term storage when their clinical state permits.

## **Ok BLOOD GROUP SYSTEM**

### ***Anti-Ok<sup>a</sup>***

CLINICAL: Anti-Ok<sup>a</sup> is a rare immune antibody that reacts with a common red cell antigen. It has been implicated in the accelerated destruction of transfused incompatible red cells, but HDN has not been reported.

TECHNICAL: Anti-Ok<sup>a</sup> is usually IgG, and reactive by the antiglobulin test. Siblings should be tested for compatibility and Ok(a-) patients urged to donate blood for long term storage when their clinical state permits. To date, all Ok(a-) people have been Japanese.

## **Ii BLOOD GROUP COLLECTION**

### ***Anti-I***

CLINICAL: Anti-I is an almost universal cold autoagglutinin found in human sera, that recognizes an almost universal red cell antigen. The antibody has no clinical significance when it is inactive at body temperature and can be ignored from the viewpoint of blood transfusion.

Since the I antigen is not well developed on cord red cells, anti-I does not cause HDN. On rare occasions potent examples of the antibody that bind complement and are active above 30EC may cause cold antibody hemolytic anemia (cold hemagglutinin disease). Such patients should be transfused with red cells warmed to physiological temperature in an approved blood warmer.

**TECHNICAL:** Anti-I is usually a common naturally-occurring IgM cold autoagglutinin, that may cause technical problems during compatibility tests. These can be avoided by performing the test strictly at 37°C, using prewarmed serum and cells, and an anti-IgG antiglobulin reagent.

### ***Anti-IH***

**CLINICAL:** Anti-IH is a naturally-occurring antibody that does not cause hemolytic transfusion reactions or HDN. If ABO-type specific blood is transfused, anti-IH can be ignored.

**TECHNICAL:** Anti-IH is an IgM cold agglutinin that reacts most strongly with group O, I-positive red cells. It is found most commonly in the serum of A<sub>1</sub> people. Compatible crossmatches can be obtained using ABO-type specific blood.

### ***Anti-I<sup>T</sup>***

**CLINICAL:** Anti-I<sup>T</sup> is an uncommon antibody. It may be a naturally-occurring cold reactive antibody, or may occur as an IgG antibody in some cases of Hodgkins disease. There is no evidence that the antibody causes *in vivo* red cell destruction and it can be ignored from the viewpoint of blood transfusion. There are no reports of HDN due to anti-I<sup>T</sup>.

**TECHNICAL:** Anti-I<sup>T</sup> is usually a naturally-occurring antibody but may be IgG. The antibody reacts most strongly against red cells from cord blood. I<sup>T</sup> is considered to be a transitional red cell antigen present in large amounts at birth and in minimal amounts in i adult and I adult red cells.

***Anti-i***

CLINICAL: Anti-i is an uncommon cold reacting antibody. It is sometimes found in disorders of the reticulo-endothelial system, mainly infectious mononucleosis. In some patients it may cause cold antibody autoimmune hemolytic anemia. If transfusion is needed in a case of hemolytic anemia due to anti-i, red cells from an I adult donor, warmed to physiological temperature in an approved blood warmer, are usually well tolerated. Transfusion reactions or HDN have not been reported.

TECHNICAL: Anti-i is usually a direct agglutinating IgM antibody most active at low temperatures. Rare examples may be IgG. Anti-i reacts most strongly with red cells from cord blood and with i adult red cells. I adult red cells have weak i antigens. The i and I antigens of human red cells have a reciprocal relationship. Potent examples of the antibody may bind complement and cause *in vitro* hemolysis of i adult red cells. Compatibility tests should be made at 37EC using anti-IgG antiglobulin reagent.

**Er BLOOD GROUP COLLECTION*****Anti-Er<sup>a</sup>***

CLINICAL: Anti-Er<sup>a</sup> is a rare antibody that reacts with a high-incidence red cell antigen. Little is known about the clinical significance of the antibody. However, it is possible that anti-Er<sup>a</sup> may cause accelerated destruction of transfused Er(a+) red cells, or mild HDN.

TECHNICAL: Anti-Er<sup>a</sup> reacts with a high-incidence antigen. The antibody is usually IgG and reactive by the antiglobulin test. Patients with anti-Er<sup>a</sup> in their serum should be recommended to

donate blood for long-term storage, in case the antibody proves to have clinical significance.

Siblings should also be tested for compatibility.

## LOBOSIDE BLOOD GROUP COLLECTION

### ***Anti-P+P<sub>1</sub>+P<sup>k</sup>***

CLINICAL: Anti-P+P<sub>1</sub>+P<sup>k</sup> (previously anti-Tj<sup>a</sup>) is found regularly in serum of the very rare PP<sub>1</sub>P<sup>k</sup>-negative people. The antibody may cause severe hemolytic transfusion reactions or HDN.

Blood of rare PP<sub>1</sub>P<sup>k</sup>-negative type must be used for transfusion.

TECHNICAL: Anti-P+P<sub>1</sub>+P<sup>k</sup> is almost always a naturally-occurring antibody with IgM and IgG components. A striking feature is its ability to hemolyze PP<sub>1</sub>P<sup>k</sup>-positive red cells *in vitro*.

PP<sub>1</sub>P<sup>k</sup>-negative cells lack P system antigens and an alternative name for the phenotype is p. Less than 1 in 50,000 random donors will be PP<sub>1</sub>P<sup>k</sup>-negative. It is important to check siblings of any PP<sub>1</sub>P<sup>k</sup>-negative patient in the quest for compatible blood and to encourage the patient to donate autologous units when the clinical condition permits.

### ***Anti-P***

CLINICAL: Anti-P is a rare antibody that reacts with a high-incidence antigen carried on globoside. Cells of the rare p phenotype are nonreactive and should be used for transfusion.

TECHNICAL: Anti-P is often strongly hemolytic against type P red cells, reacting in all phases of serological testing. Specificity will be shown only by tests against rare red cells of the PP<sub>1</sub>P<sup>k</sup>-

negative, P<sub>1</sub><sup>k</sup>, or P<sub>2</sub><sup>k</sup>, phenotypes. Siblings of patients should be tested for compatibility, and patients urged to donate for long term storage when their clinical state permits.

### ***Donath-Landsteiner Antibody***

CLINICAL: This rare antibody usually has P specificity and may be a cause of severe *in vivo* hemolysis. It may occur after a viral illness, particularly in children. Transfusion with P-positive washed red cells, infused through an approved blood warmer, is usually well tolerated.

TECHNICAL: The antibody is a bi-phasic hemolysin, which sensitizes red cells at low temperature and causes complement-mediated lysis when the temperature is subsequently increased to 37°C (the Donath-Landsteiner test).

## **SERIES OF HIGH INCIDENCE ANTIGENS**

### ***Anti-AnWj***

CLINICAL: Anti-AnWj is a rare antibody that reacts with a high incidence red cell antigen. The antibody may cause *in vivo* destruction of transfused AnWj-positive red cells. The AnWj antigen is not developed on fetal red cells and has not been found as a cause of HDN. As some examples of the antibody have clinical significance patients with anti-AnWj should be transfused with dominant inheritance Lu(a-b-) red cells since these cells have weak expression of AnWj.

TECHNICAL: Anti-AnWj is usually IgG reacting by the antiglobulin test. The antigen is absent from (or severely depressed in) persons that have inherited *In(Lu)*, the dominant suppressor gene

that also reduces the expression of Lutheran antigens. Examples of anti-AnWj have been found in association with lymphoma where the patient's cells transiently typed as AnWj-negative.

### ***Anti-At<sup>a</sup>***

**CLINICAL:** Anti-At<sup>a</sup> is a rare antibody that reacts with a high incidence red cell antigen. The antibody may cause destruction of transfused At(a+) red cells. At(a-) blood should be used for transfusion.

**TECHNICAL:** Anti-At<sup>a</sup> is usually IgG and reactive only by the antiglobulin test. The only known At(a-) red cells have been from Black people. At(a-) patients should be urged to donate blood for long term storage when their clinical state permits and siblings should be tested for the same rare type.

### ***Anti-JMH***

**CLINICAL:** Anti-JMH reacts with a high incidence antigen on red cells, but does not cause clinical problems in blood transfusion or HDN. The antibody is rare, but when encountered is most often a naturally-occurring antibody in the serum of elderly individuals. In a JM variant there was decreased RBC survival.

**TECHNICAL:** Anti-JMH reacts by the antiglobulin test with a high-incidence antigen and shows considerable variation in reaction strength against different red cell samples. It does not react with papain-treated or DTT-treated red cells.

### ***Anti-Jr<sup>a</sup>***

CLINICAL: Anti-Jr<sup>a</sup> is a rare antibody that reacts with a high-incidence red cell antigen. The antibody can cause hemolytic reactions to red cell transfusion. Jr(a-) red cells should be used for transfusion.

TECHNICAL: Anti-Jr<sup>a</sup> is usually IgG and reactive by the antiglobulin test. Siblings of immunized Jr(a-) patients should be tested for compatibility and patients urged to donate blood for long term storage when their clinical state permits. Approximately half of the Jr(a-) probands are Japanese.

### ***Anti-Lan***

CLINICAL: Anti-Lan is a rare antibody that reacts with a high-incidence antigen. The antibody can cause hemolytic reactions to transfusions of incompatible red cells, or mild HDN. Lan-negative red cells should be used for transfusion.

TECHNICAL: Anti-Lan is usually IgG and reactive by the antiglobulin test. About 1 in 4000 random individuals are Lan-negative. Patients with anti-Lan should be urged to donate blood for long term storage when their clinical state permits and siblings should be tested for compatibility.

### ***Anti-Sd<sup>a</sup>***

CLINICAL: Anti-Sd<sup>a</sup> is a not uncommon benign naturally-occurring antibody. It does not cause HDN or clinical problems in blood transfusion. It can be ignored for clinical purposes.

TECHNICAL: Anti-Sd<sup>a</sup> is a cold agglutinin that causes a characteristic mixed-field pattern of agglutination. About 91% of random donors are Sd(a+) but the antigen varies greatly in its

reaction strength on red cells from different individuals. Compatibility test made strictly at 37EC will avoid technical problems caused by this antibody. It can be inhibited by urine from guinea pigs or Sd(a+) people.

### ***Anti-Vel***

**CLINICAL:** Anti-Vel reacts with a high-incidence red cell antigen. Clinical significance is variable, but the antibody may cause destruction of transfused incompatible red cells. Vel-negative red cells should be used for transfusion. The antigen is not fully developed on cord RBCs and the antibody is not known to cause HDN.

**TECHNICAL:** Anti-Vel often has IgM and IgG components, and frequently causes hemolysis of Vel-positive red cells *in vitro*. There is evidence suggesting heterogeneity of the Vel antigen, and not all apparent Vel-negative donors will be compatible with the serum of patients who have made anti-Vel. It is important to check siblings in the search for compatible blood, and to urge Vel-negative patients to donate blood for long term storage when their clinical state permits.

## **OTHER BLOOD GROUP ANTIGENS**

### ***Anti-Bg***

**CLINICAL:** Anti-Bg is an umbrella term for a cluster of weakly agglutinating antibodies that define HLA antigens present on red cells. The antibodies do not cause HDN or potentiate destruction of transfused incompatible red cells and may be ignored from the clinical transfusion viewpoint.

TECHNICAL: Anti-Bg reacts weakly by the antiglobulin test. Specificities of anti-Bg<sup>a</sup>, anti-Bg<sup>b</sup>, and anti-Bg<sup>c</sup>, have been described, but other antibodies of similar type may be encountered that cannot be fitted into this pattern. Chloroquine-treatment of RBCs inactivates these antigens.

### ***Anti-Bg<sup>a</sup>***

CLINICAL: Anti-Bg<sup>a</sup> is a common antibody found in the serum of multiparous or multi-transfused patients. The Bg<sup>a</sup> antigen on red cells corresponds to the HLA antigen HLA-B7. Anti-Bg<sup>a</sup> does not cause *in vivo* destruction of antigen-positive red cells, or HDN. It can be ignored for clinical transfusion purposes.

TECHNICAL: Anti-Bg<sup>a</sup> is usually IgG, reacting by the antiglobulin test. Approximately 17% of donors are Bg(a+) (HLA-B7) but with considerable variation in antigen strength on their red cells

### ***Anti-Pr***

CLINICAL: Anti-Pr is an uncommon cold agglutinin that has no clinical significance when it is inactive at body temperature. Pr antigen (which is an umbrella term for a cluster of similar specificities) has a universal distribution on normal human red cells. Transfusion reactions, or HDN, caused by the antibody have not been reported. On rare occasions potent examples of the antibody, that bind complement and are active at body temperature, may cause cold antibody hemolytic anemia. Such patients should be transfused with antigen positive red cells, warmed to physiological temperature in an approved blood warmer.

**TECHNICAL:** Anti-Pr is a naturally-occurring cold agglutinin, and is usually IgM. Since no human red cells have been found that lack the Pr antigen the antibody is always an autoantibody. The Pr antigen is denatured by proteases.

### ***Anti-Rx***

**CLINICAL:** Anti-Rx is an autoantibody most active below body temperature. The antibody is a potent activator of the complement cascade and may cause hemolytic anemia. It has been found most often after a viral infection. No Rx-negative blood is known and it is recommended that washed cells or frozen blood be used for transfusion. The antibody is not known to cause HDN.

**TECHNICAL:** Anti-Rx is a rare autoantibody. The antibody is usually IgM, although a few patients have IgG antibodies. The antibody binds complement and has enhanced activity under low pH and low ionic strength conditions.