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REPORT

International Society of Blood Transfusion Committee on Terminology for Red Blood Cell Surface Antigens: Macao report

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The committee met in Macao Special Administrative Region, China, during the 2008 International Society of Blood Transfusion (ISBT) Congress. Some changes to the classification documented in Blood Group Terminology 2004 [1] and updated in 2007 [2] were agreed and are described below. The full updated classification can be found on the blood group terminology website at http://www.blood.co.uk/ibgrl. A new blood group system, the RHAG system, was established and new antigens were added to the Rh, Kell, and Dombrock systems (Table 1). A total of 308 antigens are now recognized, 270 of which are clustered in 30 blood group systems.

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System 4: Rh

One high-incidence antigen has been added to the Rh system. RH57 (CEST) is antithetical to the low-incidence antigen

Table 1 New blood group antigens

Number	Symbol	Incidence	Molecular basis[1] Common>variant	Reference
RH57	CEST	High	*RHCE* 340C>T R114W	[3]
KEL32	KUCI	High	*KEL* 1271C>T A424V	[4]
KEL33	KANT	High	*KEL* 1283G>T R428L	[4]
KEL34	KASH	High	*KEL* 758 A>G Y253C	
DO6	DOYA	High	*ART* 4547 T>G Y183D	[5]
RHAG1	Duclos	High	*RHAG* 316C>G Q106E	[8]
RHAG2	Ol[a]	Low	*RHAG* 680C>T S227L	[8]
RHAG3[2]	DSLK	High	*RHAG* 490 A>C K164Q	[8]

[1]Numbers for nucleotide and amino acid location, counting from A of initiating methionine codon and that methionine residue, respectively.
[2]Provisional assignment.

RH48 (JAL) and is defined by an antibody produced by an RH:48,–57 patient who is homozygous for an *RHCE* allele encoding RH48 and an Arg114Trp substitution in the RhCcEe protein [3] (Table 1).

System 6: Kell

Three antigens of high incidence were added to the Kell system: KEL32 (KUCI), KEL33 (KANT) and KEL34 (KASH). Antibodies defining these antigens were non-reactive with K_0 (Kell-null) red blood cells.

The KEL:–32 proposita and her KEL:–32 sister are heterozygous for a *KEL* allele encoding Ala424Val. No cause for the apparent silencing of the *KEL* gene *in trans* was found [4]. Anti-KEL33 was produced in an individual heterozygous for a *KEL* allele encoding Arg428Leu and for a known *KEL*0* allele [4]. KEL:–32 red blood cells are also KEL:–33, but KEL:–33 cells are KEL:32. The antibody defining KEL34 (KASH) is non-reactive with the red blood cells of the antibody maker and with those of her sister. Both the KEL:–34 propositus and her KEL:–34 sister have a K_{mod} phenotype and are homozygous for a *KEL* allele encoding a Tyr253Cys substitution (Poole J, Karamatic Crew, V, unpublished observations).

System 14: Dombrock

DO6 (DOYA) is defined by an antibody to a high-incidence antigen produced in a patient who was homozygous for *DO*1* (793A) and for a novel *DO* mutation encoding Tyr183Asp (Table 1). The red blood cells of the antibody maker are DO:–1,–2 with weakened expression of DO3, DO4, and DO5. Anti-DO6 reacts with red blood cells of common Dombrock type, but weakly with DO:–4 (Hy–) and DO:–5 [Jo(a–)] red blood cells, and is non-reactive with DO:–3 [Gy(a–)] cells [5].

System 30: RHAG

RHAG is a new blood group system comprising three antigens, one of which is assigned provisionally. Antigens of this system appear to be located on the Rh-associated glycoprotein (CD241) encoded by the *RHAG* gene [6].

RHAG1 (Duclos) was previously the high-incidence antigen 901013. The antibody defining RHAG1 (Duclos) reacts with all red blood cells apart from those of the antibody maker and those Rh_{null} red blood cells that lack MNS5 (U) [7]. The antibody maker, whose red blood cells had normal Rh antigens and slightly weakened MNS5 [8], was homozygous for 316C>G in *RHAG* encoding Gln106Glu (Table 1). HEK293 cells expressing normal *RHAG* reacted with anti-RHAG1, whereas those expressing *RHAG* containing 316C>G did not [8].

RHAG2 (Ol[a]) was previously the low-incidence antigen 700043. The original family study showed that RHAG2 expression is associated with weakened expression of Rh antigens, but that the gene governing RHAG2 is not located at the Rh locus [9]. Two RHAG:2 members of the original family are heterozygous for a nucleotide change in *RHAG* encoding Ser227Leu close to the fourth predicted loop of the Rh-associated glycoprotein [8]. In addition, red blood cells of a Japanese individual with the Rh_{mod} phenotype and homozygous for the Ser227Leu mutation [10] were subsequently shown to be Ol(a+) (Tilley L, Poole J, Daniels G, unpublished observations).

RHAG3 (DSLK) is a high-incidence antigen defined by an antibody with reactivity characteristics similar to those of anti-RHAG1 (non-reactive with Rh_{null} MNS:–5 cells, reactive with Rh_{null} MNS:5 cells), but the red blood cells of the RHAG:–3 antibody maker were RHAG:1. This RHAG:–3 patient was homozygous for a mutation in *RHAG* encoding Lys164Gln [8]. Owing to incomplete evidence, RHAG3 is provisionally assigned to the RHAG system. DSLK was initially named DL [8], but changed to DSLK (from letters in 'Duclos-like') to comply with the rule that symbols for designating new specificities will consist of three to six on-line, capital letters [1].

700 series

700043 (Ol[a]) has been assigned RHAG2 and is now obsolete.

901 series

901013 (Duclos) has been assigned RHAG1 and is now obsolete.

Superscripts and subscripts

Many of the traditional symbols for blood group antigens and phenotypes incorporate superscripts and subscripts. In circumstances where superscripts and subscripts are not available, the superscript or subscript should be written on the line. For example, Jk^a would be Jka.

Future considerations

Work is continuing on the establishment of a terminology for blood group alleles and on the development of a new collection containing antigens on glycophorin A that are determined primarily by glycosylation, including Hu, M_1, Tm, Sj and Can.

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Dr Cyril Levene has retired from the committee. We would like to thank him for his contributions over many years.

References

1 Daniels GL, Fletcher A, Garratty G, Henry S, Jørgensen J, Judd WJ, Levene C, Lomas-Francis C, Moulds JJ, Moulds JM, Moulds M, Overbeeke M, Reid ME, Rouger P, Scott M, Sistonen P, Smart E, Tani Y, Wendel S, Zelinski T: Blood group terminology 2004. From the ISBT Committee on Terminology for red cell surface antigens. *Vox Sang* 2004; **87**:304–316

2 Daniels G, Flegel WA, Fletcher A, Garratty G, Levene C, Lomas-Francis C, Moulds JM, Moulds JJ, Olsson ML, Overbeeke M, Poole J, Reid ME, Rouger P, van der Schoot E, Scott M, Sistonen P, Smart E, Storry JR, Tani Y, Yu L-C, Wendel S, Westhoff C, Zelinski T: International society of blood transfusion committee on terminology for red cell surface antigens: cape town report. *Vox Sang* 2007; **92**:250–253

3 Lomas-Francis C, Reid ME, Westhoff C, Alcantara D, Nickle P, Uehlinger J: JAL (RH48) blood group antigen: serological observations. *Transfusion* 2008; **48**(Suppl.):14A–15A (Abstract)

4 Velliquette RW, Sausais L, Lomas-Francis C, Wu X, Lee S, Reid ME, Gillen B, Beatty CE, Thomas R, Schierts JD, Gentzkow K, Schafer J, Reinke D: Two novel and related high-prevalence antigens in the Kell blood group system. *Transfusion* 2007; **47**(Suppl.):164A–165A (Abstract)

5 Warke N, Poole J, Mayer B, Bartomaes T, Yurek S, Hue-Roye K, Lomas-Francis C, Reid ME: New antigen in the Dombrock blood group system: DOYA. *Transfusion* 2008; **48**(Suppl.):209A (Abstract)

6 Ridgwell K, Spurr NK, Laguda B, Macgeoch C, Avent ND, Tanner MJA: Isolation of cDNA clones for a 50 kDa glycoprotein of the human erythrocyte membrane associated with Rh (Rhesus) blood-group antigen expression. *Biochem J* 1992; **287**:223–228

7 Habibi B, Fouillade MT, Duedari N, Issitt PD, Tippett P, Salmon C: The antigen Duclos. A new high frequency red cell antigen related to Rh and U. *Vox Sang* 1978; **34**:302–309

8 Tilley L, Gaskell A, Poole J, Daniels G: Duclos-negative and Ol(a+) blood group phenotypes are associated with amino acid substitutions in the external loops of the Rh-associated glycoprotein. *Vox Sang* 2008; **95**(Suppl. 1):37 (Abstract)

9 Kornstad L: A rare blood group antigen, Ol^a (Oldeide), associated with weak Rh antigens. *Vox Sang* 1986; **50**:235–239

10 Tsuneyama H, Ogasawara K, Uchikawa M, Yabe R, Nakajima K: Identification of two new mutations in the RhAG gene of Japanese with Rh_{mod} phenotype. *Transfusion* 2008; **48**(Suppl.):185A–186A (Abstract)

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