



# ANTICORPI ANTI HLA NEL TRAPIANTO CSE

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## The European Society for Blood and Marrow Transplantation (EBMT) Consensus Guidelines for the Detection and Treatment of Donor-specific Anti-HLA Antibodies (DSA) in Haploidentical Hematopoietic Cell Transplantation

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**Anticorpi anti HLA e trapianto di Cellule Staminali Emopoietiche**

Valeria Miotto

AIBT Summer School-Ercolano, 13-15 giugno 2019

## BSHI Guideline: HLA matching and donor selection for haematopoietic progenitor cell transplantation

A-M. Little<sup>\*††</sup>, A. Green<sup>‡</sup>, J. Harvey<sup>‡</sup>, S. Hemmatpour<sup>§</sup>, K. Latham<sup>¶</sup>, S. G. E. Marsh<sup>¶\*\*\*</sup>,  
K. Poulton<sup>††‡‡</sup> & D. Sage<sup>§</sup>

- HLA alloantibody testing of the recipient should be performed at the time of donor search and should be repeated at the time of donor work-up request if an HLA-mismatched donor is selected (Grade 1A)
- The clinical team must be made aware of any HLA alloantibody incompatibility for a selected donor (Grade 1A)
- When a choice of equally well-matched donors is available, avoid selection of donors against which the patient has HLA alloantibodies (Grade 1A)
- HLA alloantibody testing should be performed in cases of failed engraftment if the donor is HLA mismatched (Grade 1B)

## BSHI GUIDELINE #1

ALTERNATIVE PROGENITOR CELL DONORS  
(CORD BLOOD OR HAPLOIDENTICAL)  
SHOULD BE CONSIDERED EARLY IN THE  
DONOR SEARCH WHEN A PATIENT IS  
UNLIKELY TO HAVE AN HLA-MATCHED  
UNRELATED DONOR (GRADE 1A)

*Haplo vs. MUD: Help!*



# ISTOCOMPATIBILITÀ NEL TRAPIANTO DI MIDOLLO OSSEO DA DONATORE APLOIDENTICO: NUOVE TECNICHE E TOOLS BIOINFORMATICI

## TMO HLA IDENTICO

- MIGLIOR MATCH

## TMO APLOIDENTICO

- MISMATCH HLA
- ANTICORPI ANTI-HLA DONOR (DSA)
- RIDOTTA IMMUNOCOMPETENZA  
GRAFT

PRIMARY GRAFT FAILURE: 4% (MUD), 20% (HAPLO + UCB)  
Davies, Blood 2000

- HLA MISMATCH  
(MMUD, UCB, HAPLO)

recipient (residual) T CELLS  
preformed DSA    C'  
ADCC

OTHER AFFECTING FACTORS:

- RECIPIENT

MAC/RIC

STROMAL DEFECTS

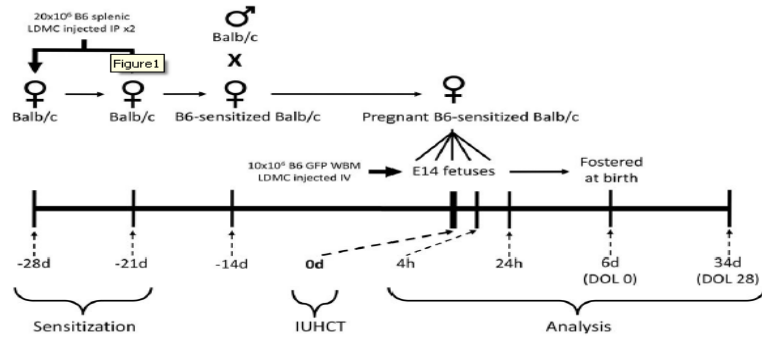
- GRAFT                      CD34

ABO INCOMPATIBILITY

T DEplete/REplete

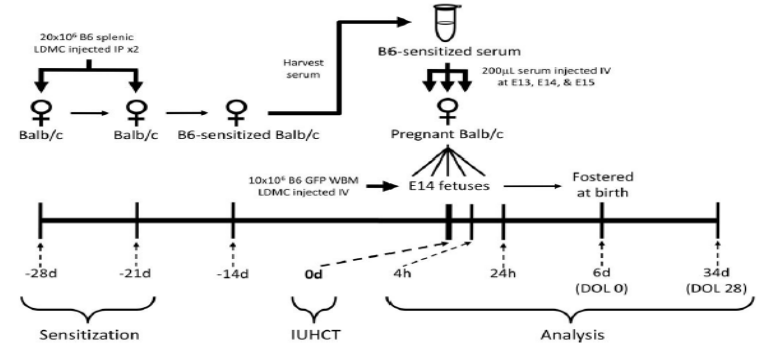
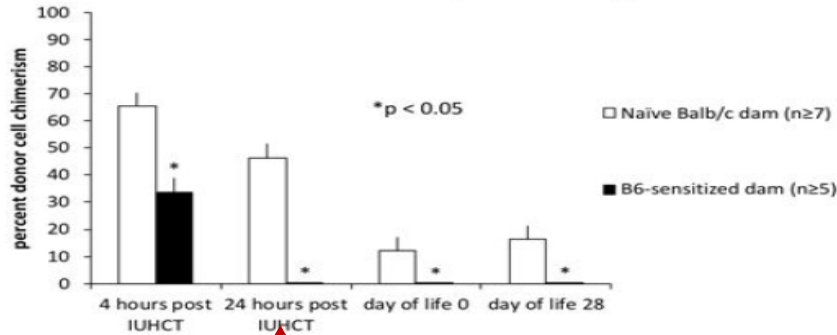
- MYELOSUPPRESSIVE DRUG
- VIRAL INFECTIONS/SEPSIS

# Pre-existing Maternal Antibodies Cause Rapid Prenatal Rejection of Allotransplants in the Mouse Model of In Utero Hematopoietic Cell Transplantation



## DIRECT SENSITIZATION

Chimerism at various timepoints following IUHCT



## INDIRECT SENSITIZATION

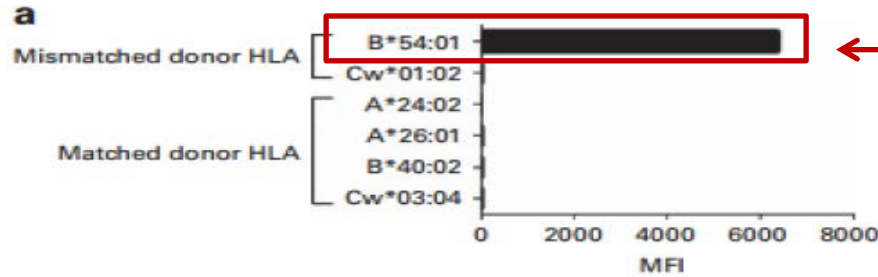
	4 hours post IUHCT	24 hours post IUHCT	day of life 0	day of life 28
Naïve Balb/c dam	8 / 8 (100%)	11 / 11 (100%)	11 / 11 (100%)	52 / 54 (96%)
B6-sensitized dam	9 / 9 (100%)	0 / 5 (0%)	0 / 7 (0%)	0 / 39 (0%)

Efficiency of engraftment at 4 and 24 hours post IUHCT and days of life 0 and 28. The number of fetuses in naïve and B6-sensitized Balb/c dams that demonstrated donor cell engraftment > or equal to 1% at the various times points is indicated.

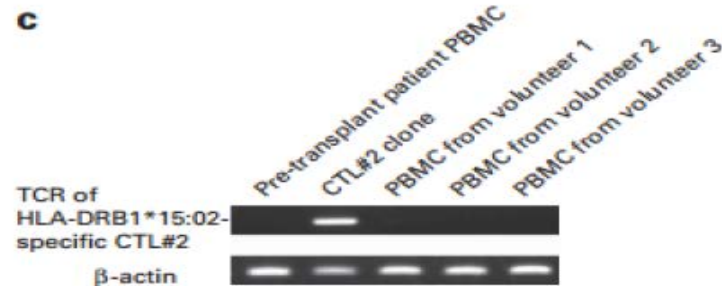
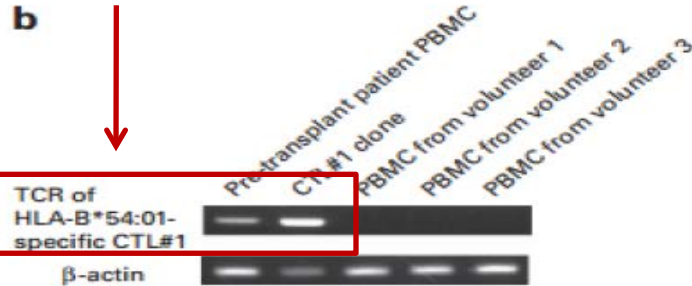


# Integration of humoral and cellular HLA-specific immune responses in cord blood allograft rejection

a case of cord blood allograft rejection in which DSA and cytotoxic T lymphocyte (CTL) specific for donor HLA-B\*54:01 were detected at the time of graft rejection. Both the DSA and CTL inhibited colony formation by unrelated bone marrow mononuclear cells sharing HLA-B\*54:01, suggesting that the humoral and cellular immune responses were involved in the graft rejection.



sCTL + DSA





## BSHI GUIDELINE #2

HLA ANTIBODY SEARCH SHOULD BE  
PERFORMED AT THE TIME OF DONOR SEARCH  
(GRADE 1A)

*Donor selection: the devil is in DSA?*

# Prevalence and risk factors of antibodies to human leukocyte antigens in haploidentical stem cell transplantation candidates: A multi-center study

**Table 2**

Logistic regression analysis of PRA in 1663 allogeneic stem cell transplantation candidates.

	Class I (+) (n = 306)			Class II (+) (n = 169)			Class I or II (+) (n = 349)			Class I and II (+) (n = 126)		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Gender (male vs. female)	0.551	0.380–0.798	0.002	0.724	0.423–1.241	0.240	0.648	0.453–0.928	0.018	0.466	0.254–0.856	0.014
Number of transfusions( $\leq 6$ vs. $> 6$ )	0.540	0.408–0.714	$< 0.001$	0.526	0.368–0.752	$< 0.001$	0.516	0.393–0.676	$< 0.001$	0.539	0.361–0.805	0.003
Number of pregnancies												
0	0.419	0.244–0.717	0.002	0.143	0.072–0.284	$< 0.001$	0.249	0.148–0.422	$< 0.001$	0.284	0.133–0.605	0.001
1	0.954	0.601–1.513	0.840	0.591	0.358–0.974	0.039	0.702	0.448–1.102	0.124	0.845	0.487–1.466	0.550
$\geq 2$		1			1			1			1	
Diagnosis												
AML	0.800	0.479–1.335	0.393	1.122	0.523–2.407	0.767	0.882	0.532–1.464	0.628	0.915	0.407–2.053	0.829
ALL	0.481	0.281–0.882	0.007	0.717	0.324–1.589	0.413	0.525	0.310–0.890	0.017	0.578	0.246–1.357	0.208
MDS	1.634	0.933–2.862	0.086	3.082	1.389–6.841	0.006	1.950	1.120–3.394	0.018	2.470	1.065–5.733	0.035
AA	0.895	0.469–1.708	0.737	2.100	0.854–5.165	0.106	1.189	0.638–2.215	0.585	1.266	0.462–3.465	0.646
Others		1			1			1			1	

	HLA-A	HLA-B	HLA-C	HLA-DP	HLA-DQ	HLA-DR
Absolute numbers	260	287	175	93	141	161
Prevalence (%)	15.6%	17.3%	10.5%	5.6%	8.5%	9.7%

Table 2a. The Overall Incidence of Any HLA-Specific Abs and DSA by Gender and Pregnancy History

Patient Group (N)	Any HLA-Specific Abs	Donor HLA-Specific Abs
All candidates (296)	68 (23.0%)	43 (14.5%)
Males (185)	20 (10.8%)	9 (4.9%)
Females (111)	48 (43.2%)	34 (30.6%)
Parous females (63)	33 (52.4%)	27 (42.9%)
Nulliparous females (48)	15 (31.3%)	6 (12.5%)

FEMALE: DSA UP TO  
40%

Table 2b. Characterization of the DSA for the 42 Candidates with DSA

DSA to Donors Evaluated (N)	Weak DSA*	Moderate-to-Strong DSA†
Haploidentical (117)	37 (31.6%)	80 (68.4%)
Mismatched unrelated (15)	8 (53.3%)	7 (46.7%)

Gladstone, BBMT 2013

	N.	Pos	%	cPRA >50%	MFI > 5000	MFI > 10000	C1q Pos	C1q %
tot	91	40	44%	13	19	14	10	25%
M	55	19	35%	4	4	3	3	21%
F	36	21	58%	9	15	11	7	33%

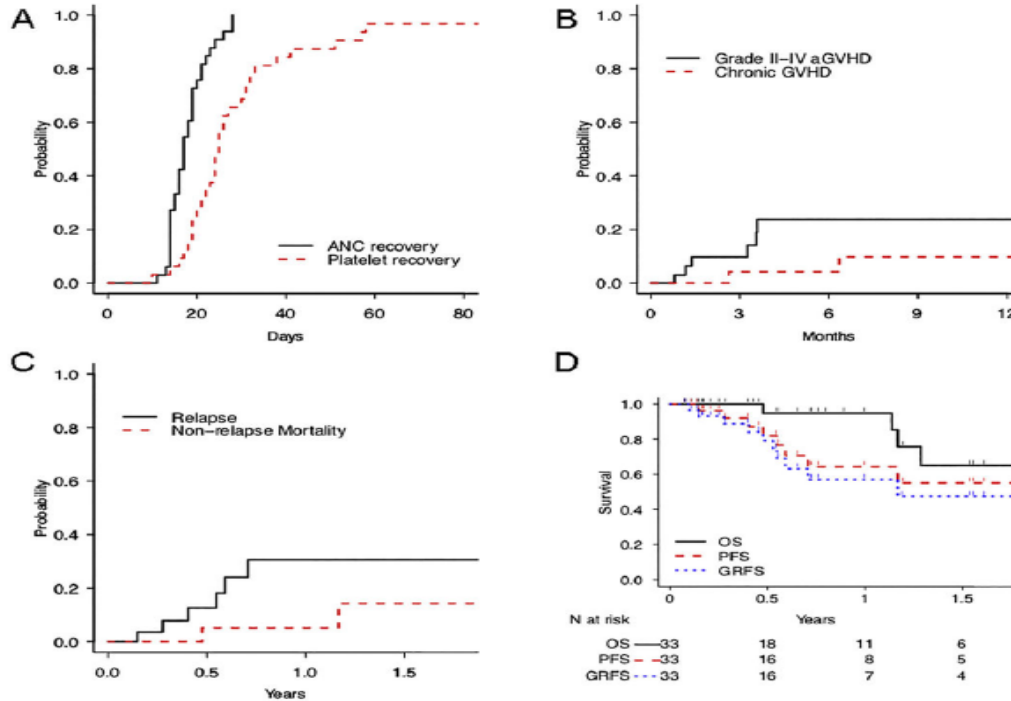
LUMINEX  
C1Q

DSA: 24,3%, M 21,7%, F 28,5%  
C1Q: 25%, M 21%, F 33%



FAMIGLIA ESTESA!

# Haploidentical Bone Marrow Transplantation with Post-Transplant Cyclophosphamide Using Non-First-Degree Related Donors



HAPLO BMT WITH PTCY FROM NON- FIRST-DEGREE RELATED DONORS IS EQUIVALENT TO HAPLO BMT WITH FIRST-DEGREE RELATED DONORS

Elmariah, BBMT 2018

## Key Points

- In unmanipulated haplo-HSCT, antigenic HLA-DRB1 match, stem cell source, conditioning, and donor sex are associated with GVHD.
- The role of HLA-matching status and other factors influencing alloreactivity is more prominent with PTCy compared to ATG GVHD prophylaxis.

## The impact of HLA matching on outcomes of unmanipulated haploidentical HSCT is modulated by GVHD prophylaxis

n Based on these data, the role of HLA mismatching on unshared haplotype appears not to be sufficiently prominent to justify its consideration in haploidentical donor selection. However, the role of HLA matching in haploidentical HSCT might be modulated by GVHD prophylaxis, calling for further investigations in this increasingly relevant field.

Lorentino, Blood Adv 2018

Proposed Scoring System for Donor Selection

DonorVariable		OS		DFS		Relapse	
		$\beta$	Score	$\beta$	Score	$\beta$	Score
Relation	Child	-1.12	3	-1.23	3	-1.31	3.25
	Sibling	-.81	2	-.84	2	-.98	2.5
CMV serostatus	D CMV+ or R CMV-	-.93	2.5	-.91	2.5	-.71	1.75
HLA $\times$ /10 mismatch (GVH)	$\geq 4$ mismatch	-.05	0	-.51	1.5	-1.23	3
HLA-DR (GVH)	Mismatch GVH	-1.00	2.5	-.58	1.5	.06	0
HLA-DP	Nonpermissive mismatch	-.63	1.5	-.82	2	-1.33	3.25
KIR R-L	Mismatch	-.47	1	-.56	1.5	-.89	2.25
KIR Haplotype	B/ $\times$ with 2DS2	-.92	2.5	-.87	2	-.84	2
	A/A	-.08	0	-.08	0	-.45	1

Selecting the Best Donor for Haploidentical Transplant: Impact of HLA, Killer Cell Immunoglobulin-Like Receptor Genotyping, and Other Clinical Variables

Solomon, BBMT 2018

## BSHI GUIDELINE #3

THE CLINICAL TEAM MUST BE MADE  
AWARE OF ANY HLA ALLOANTIBODY  
INCOMPATIBILITY FOR A SELECTED DONOR  
(GRADE 1A)

*Graft failure: DSA matters!*



Table 2. Type and specificity of donor-specific anti-HLA Abs in matched unrelated donor transplant recipients

n	Anti-DP DSA	MFI value before first SCT	Subunit	Epitope*	Ags within epitope, n†	MFI for epitope‡	Engrafted	Second SCT	MFI second SCT	Engrafted
1	0401	1558	DPB1	A 56	4	880-1558	Y	N	N/A	N/A
2	0301	4341	DPB1	EAV 85-87	9	2723-8531	N	N	N/A	N/A
3	0301	2759	DPB1	EAV 85-87	11	971-3072	N	Y	0	Y
4	0101	3733	DPB1	EAV 85-87	11	1787-7781	Y	N	N/A	N/A
5	0101	4924	DPB1	EAV 85-87	11	552-4924	Y	N	N/A	N/A
	1101	1019								
6	1401	5597	DPB1	E 56	8	4835-8419	Y	N	N/A	N/A
7	2001	3990	DPB1	K/R 69-M 76	6	1583-6411	N	N	N/A	N/A
8	1001	9485	DPB1	EAV 85-87	10	2320-9485	Y	N	N/A	N/A

			GF	
total	592		16	2.7%
DPB1 MM	430	72.6%		
HLA ab	116	19.6%		
DPB1 ab	20	3.4%		
DPB1 DSA	8		3	37.5%
				p<0.0001, OR=21.3

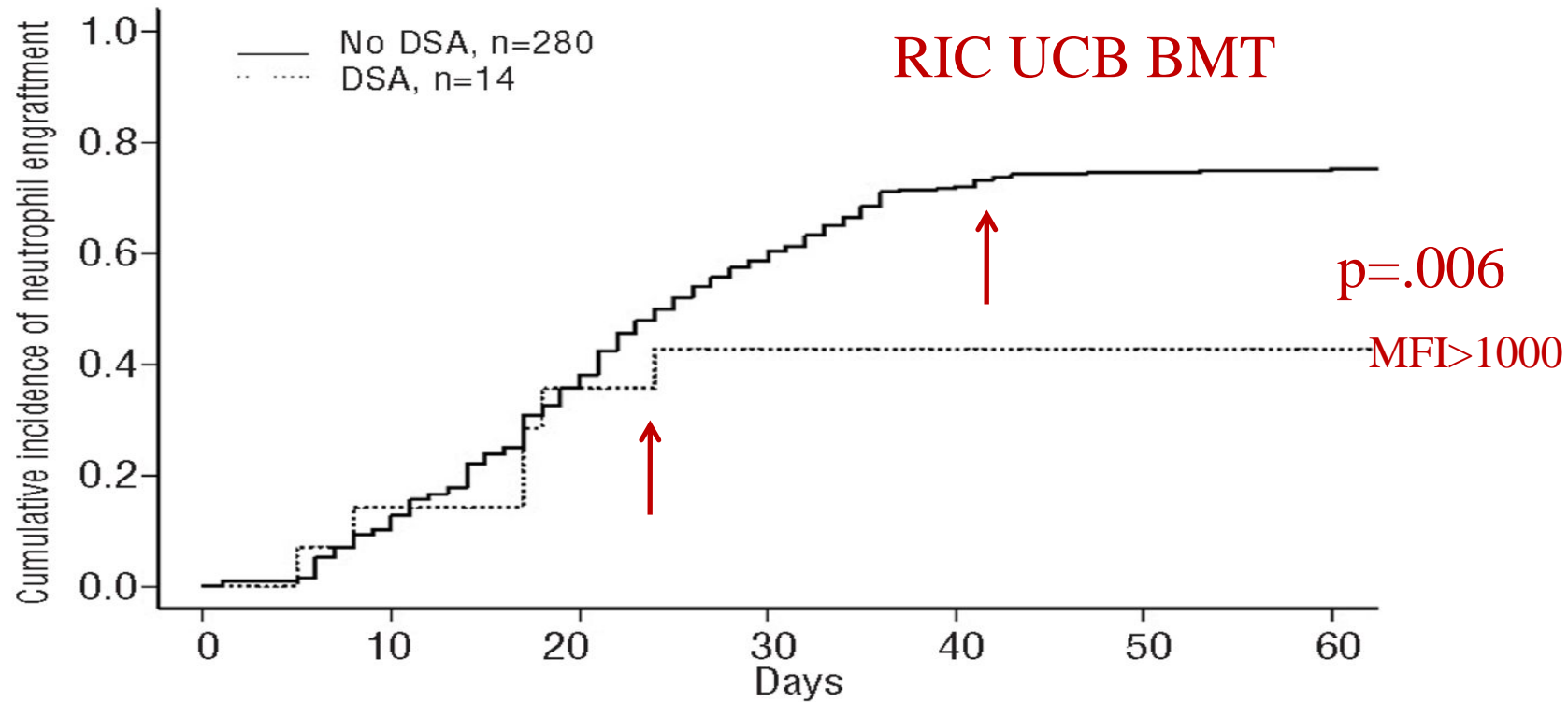
RIC+MAC

MUD

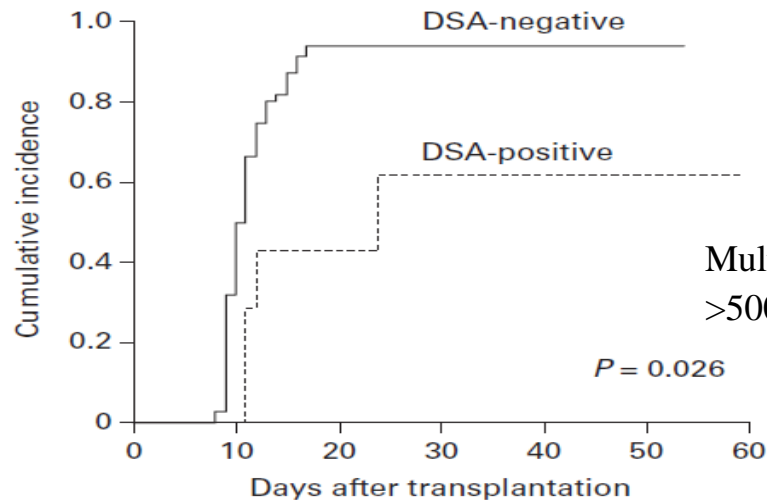
DPB1

TCE HVG NON PERMISSIVE!

The cumulative incidence of engraftment at 60 days by DSA. The solid line represents no DSA and the dashed line represents the DSA.



Ruggeri, Haematologica 2013



**MFI > 5000**

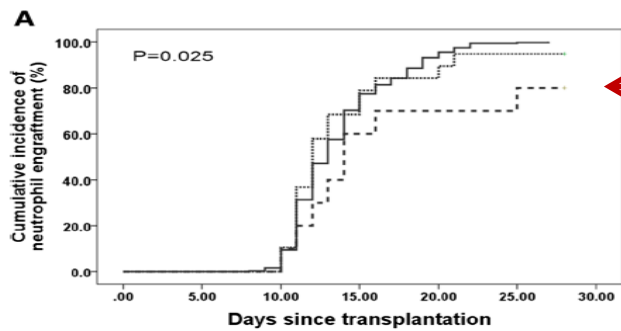
Multivariate analysis showed that pretransplant presence of DSA MFI > 5000) was the only significant risk factor for graft failure ( $P < 0.006$ ).

Neutrophil engraftment

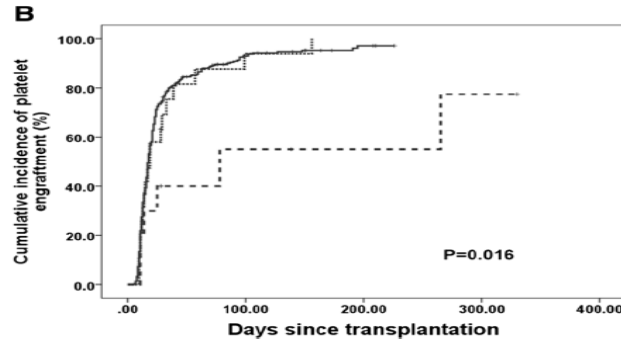
		GF
PTS	79	
HLA	16	
DSA	11	
DSA AT TX	7	3
NO DSA AT TX	72	3

**MAC/RIC  
HAPLO-IDENTICAL  
UNMANIPULATED BMT**

**Yoshihara, BMT 2012**



GRAFT REJECTION:  
MFI > 10000 (ROC)



A THRESHOLD FOR DSA  
ACCORDING TO MFI

**Fig. 1** Pretransplant DSA and cumulative incidence of neutrophil (a) and platelet (b) engraftment. All patients were classified into three groups, group A includes cases with DSA negative and those with a DSA MFI < 2000 ( $n = 316$ , solid line), group B includes cases with  $2000 \leq \text{MFI} < 10,000$  ( $n = 19$ , dotted line), and group C includes those with a  $\text{MFI} \geq 10,000$  ( $n = 10$ , dashed line)

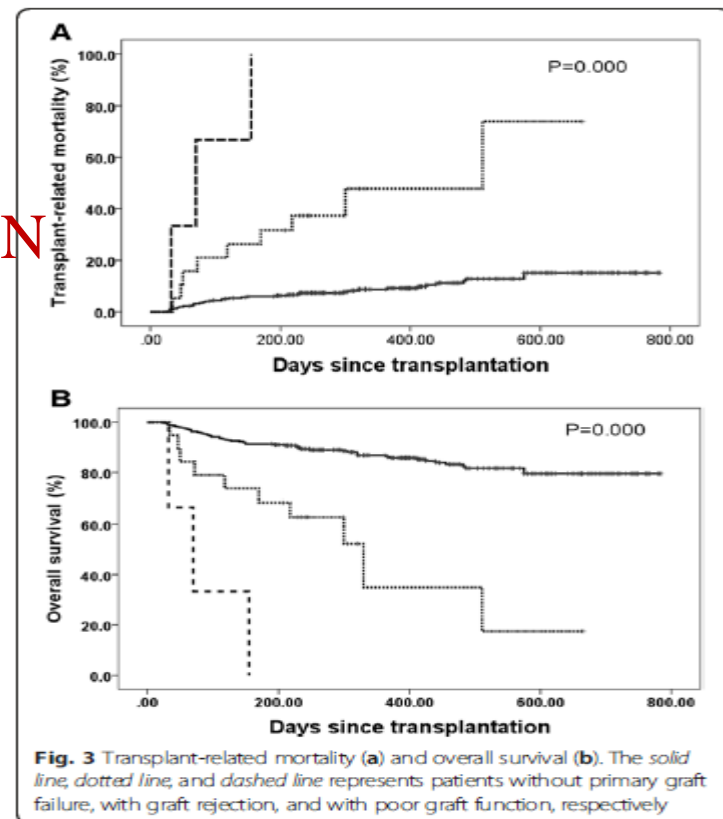
HAPLO-BMT (MAC, ATG): 349 pts: GR + PGF

Chang, JCO 2015

# PRIMARY GRAFT FAILURE: REJECTION + POOR GRAFT FUNCTION THRESHOLD MFI > 2000

**Table 2** Multivariate analysis of factors associated with transplant outcomes

	HR	95 % CI	P value
Primary graft failure			
DSA			
MFI $\geq 10,000$	1		
$2000 \leq \text{MFI} < 10,000$	0.940	0.284–3.177	0.919
MFI < 2000	0.187	0.048–0.730	0.016



## BSHI GUIDELINE #4

WHEN A CHOICE OF EQUALLY WELL-MATCHED  
DONORS IS AVAILABLE, AVOID SELECTION OF  
DONORS AGAINST WHICH THE PATIENT HAS  
HLA ALLOANTIBODIES (GRADE 1A)

*DSA: I'd rather not*



# The European Society for Blood and Marrow Transplantation (EBMT) consensus recommendations for donor selection in haploidentical hematopoietic cell transplantation

Stefan O. Ciurea<sup>1</sup> et al.

## T cell depleted haploidentical transplants

-No DSAs (MFI < 1000)

-NK cell alloreactive donor

-Younger donor over older donor

-Male donor for a male recipient

-First degree relative over second degree HLA half-matched donor

-Between parent donors, mother is preferred over father

-ABO matched donor

-CMV seropositive donor for CMV seropositive recipients

## T cell replete haploidentical transplants

-No DSAs (MFI < 1000)

-Younger donor over older donor

-Male donor for a male recipient

-Sibling or offspring donor over parent donor

-Between parent donors, father is preferred over mother donor

-ABO matched is preferred to minor ABO mismatch to major ABO mismatched donor

-Donor with KIR ligand match for a recipient of HHCT<sup>a</sup>

-First degree relative over second degree HLA half-matched donor<sup>a</sup>

-Donor with NIMA mismatch over NIPA mismatch for a recipient of HHCT<sup>a</sup>



REVIEW

Open Access



# The consensus on indications, conditioning regimen, and donor selection of allogeneic hematopoietic cell transplantation for hematological diseases in China—recommendations from the Chinese Society of Hematology

**TABLE 1** Summary of factors in selecting best haploidentical donor

Factors	TCD	TCR Beijing protocol	TCR PTCy	General comments
HLA disparity extent	—	No impact	No impact	Not considered
Specific HLA loci	—	Each HLA allele mismatch had different effect.	HLA-DR HLA-DP	Specific HLA loci might have impact
DSA	GF↑	GF↑	GF↑	DSA should be avoided
Donor age	<40, NRM↓	<30, NRM↓, OS↑	<40, NRM↓, OS↑, with controversy	Younger donor preferred, with some controversy
Donor gender	No impact	Male, NRM↓, GVHD↓	No impact	Not clearly defined
Family relationship	Mother preferred	Offspring>sibling>father>mother	No data	Not clearly defined
ABO blood type	—	—	ABO major mismatch, GF↑, GVHD↑	ABO-matched donor is preferred
NK alloreactivity	KIR mismatch, relapse↓	KIR mismatch, relapse↑	KIR R-L mismatch and KIR B/x 2DS2 haplotype, relapse↓, OS↑	Controversial
CMV serological status	CMV-/-patient/donor, LFS↑	No impact	No impact	A CMV-seronegative donor is preferred for CMV-seronegative patient
Others	—	—		Higher BMI better

# Selection of unrelated donors and cord blood units for hematopoietic cell transplantation: guidelines from the NMDP/CIBMTR

**Table 1. Guidelines for unrelated donor selection**

	Multiple HLA-A, HLA-B, HLA-C, and HLA-DRB1 (8/8) HLA matched unrelated donors available	8/8 match unavailable; multiple 7/8 unrelated donors available
6. DSA in patient	Avoid mismatches of allotypes targeted by DSAs, including DQA1 and DPA1	Avoid mismatches of allotypes targeted by DSAs, including DQA1 and DPA1

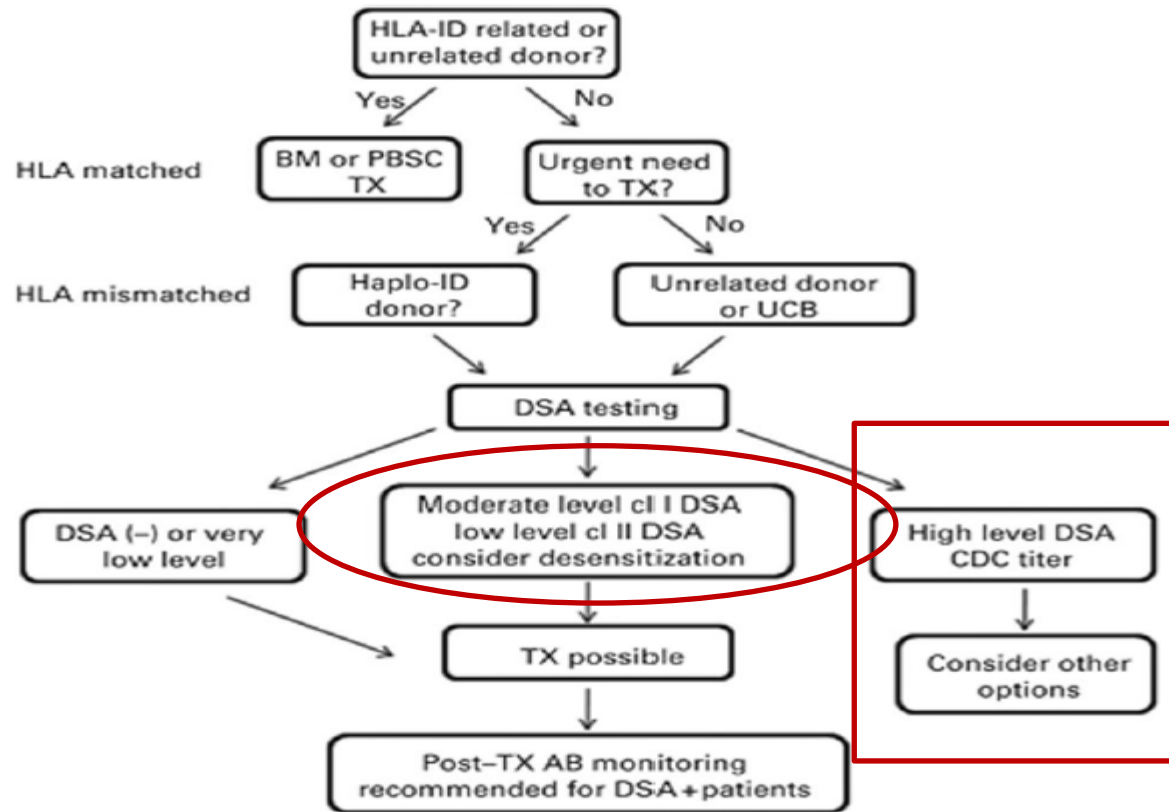
**Table 2. Unrelated CB unit selection guidelines**

	Guidelines
Avoidance of units against which recipient has DSAs	Conflicting results in hematological malignancies; avoid if nonmalignant diagnosis

## BSHI GUIDELINE #5

HLA ANTIBODY SEARCH SHOULD BE  
REPEATED AT THE TIME OF DONOR WORK-UP  
REQUEST IF AN HLA-MISMATCHED DONOR  
IS SELECTED (GRADE 1A)

*Desensitize? do not rely on MFI!*



EVALUATION BMT CANDIDATES FOR BMT

Leffell, BMT 2015

# Alloantibody Reduction after Desensitization

Patient No.	Number of PP/IVIG Treatments	% Antibody Reduction*			
		DSA		Third-Party Antibodies†	
		EOT‡	F/u§	EOT	F/u
1	7	93.9			
2	5	59.5	93.8	46.9	-16.4
3	3	33.1	96		
4 - DSA 1	3	86	99.1	83.4	83.8
4 - DSA 2		82	98.6		
4 - DSA 3		81.6	98.7		
5	5	52.1	96.9	11.4	29.5
6	4	44.3	73	4.3	6.4
7	7	64.7			
8	3	74	99.9	39.1	76.8
9	11	77.4	98.4		
Mean	5.3	68.1	94.9	37.0	36.0
SD	2.6	19.0	8.4	31.5	43.6

PP indicates plasmapheresis; IVIG, intravenous immunoglobulin; DSA, donor-specific antibody; EOT, end of desensitization treatment; F/u, follow-up.

## Post-transplantation Clinical Status

Patient No.	Donor Chimerism*	GVHD	Disease Relapse	Follow-Up Time (Months)†
1	100%	no	no	35
2	94%	no	3 months	died: 17 months
3	>95%	no	5 months	died: 7 months
4	100%	chronic skin	no	21
5	100%	grade 1 skin	12 months	died: 18 months
6	100%	no	16 months	18
8	100%	grade 1 skin	no	7
9	100%	no	no	3

\* Degree of donor chimerism determined at transplant day +60.

† Continued donor hematopoiesis was documented for all patients at last follow-up.

HAPLO + MMUD BMT: 296 pts, 43 DSA,  
9 pts (w/o alternative donors):  
DESENSITIZATION

Gladstone, BBMT 2013

# Comprehensive Assessment and Standardization of Solid Phase Multiplex-Bead Arrays for the Detection of Antibodies to HLA

FALSE POSITIVE TOO HIGH MFI	denatured antigen	A80, B76, Cw17
	Bead density vs. allele expression	HLA-C, DP
	“hot beads”	DR16, DRB1*04:04
FALSE NEGATIVE TOO LOW MFI	prozone	EDTA, DTT
	shared epitopes	Bw4, Bw6
	allele not represented	C*07:01
	peak single vs. multiple DSA	I + II class
	bead saturation	Serum dilution
FALSE INTERPRETATION	Allele subtype positive	Only DRB1*04:02

**DO NOT RELY ON MFI!**

*Reed, Am J Transpl 2013; 13:1859-1870*

# Successful engraftment in recipients of haploidentical stem cells with donor-specific antibodies: role of flow cytometric cross-match

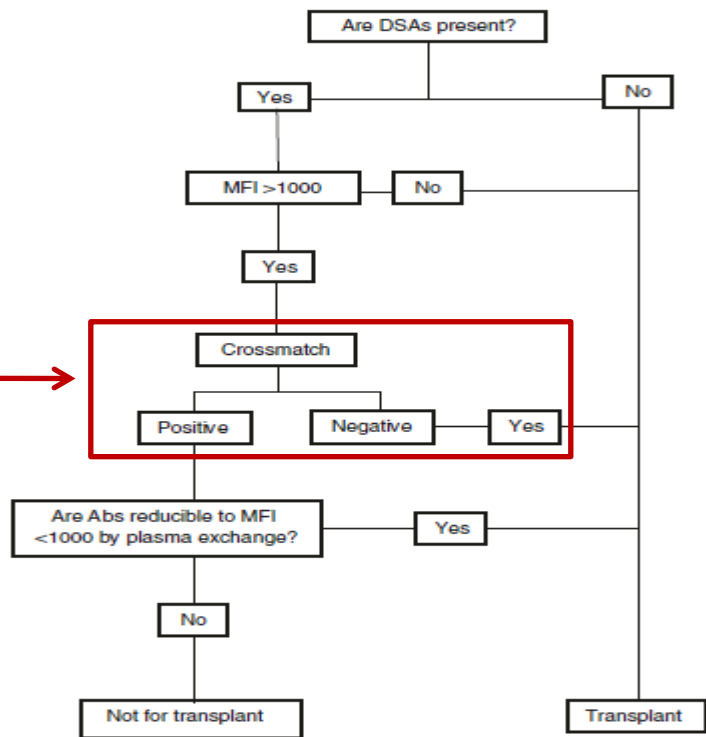
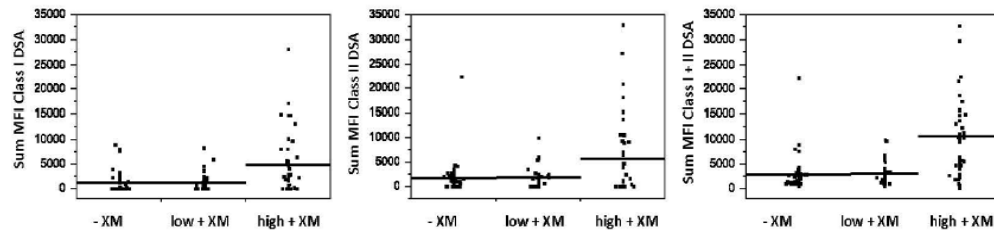


Fig. 1 Algorithm for approach to DSA

Gallanagh, BMT 2019



FC-XM vs. MFI

Schinstock, Transpl 2018

Firenze, desensitize if:

FCXM T + B POS

DSA MFI > 5000

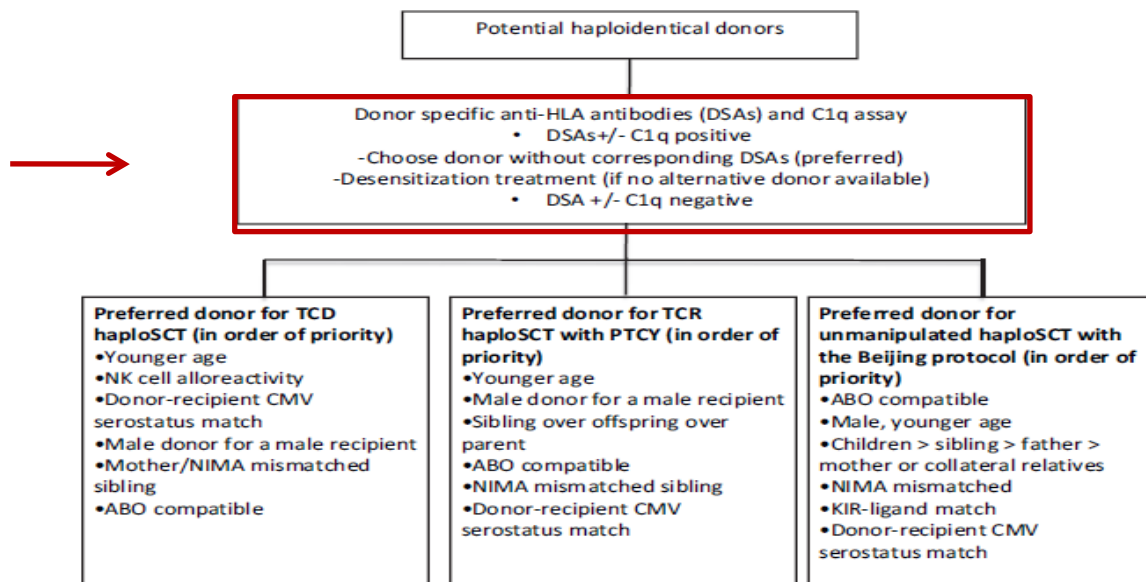
C1q, CDC POS

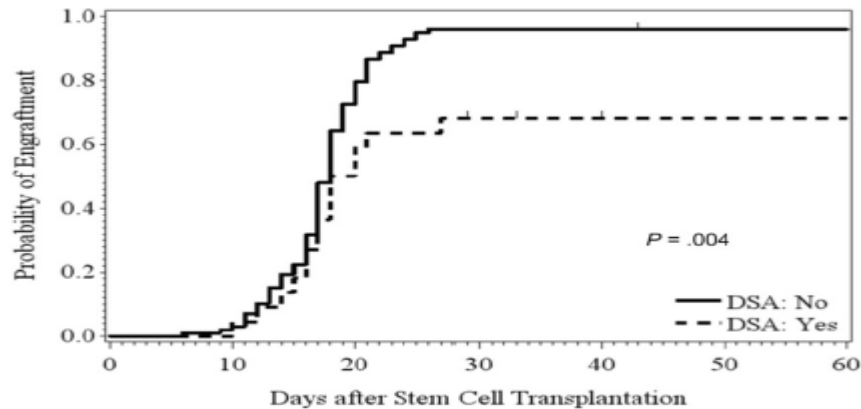




## Review

## Who is the best donor for haploidentical stem cell transplantation?

Piyanuch Kongtim<sup>a</sup>, Stefan O. Ciurea<sup>b,\*</sup><sup>a</sup> Division of Hematology, Department of Internal Medicine, Faculty of Medicine, Thammasat University, Khlong Luang, Pathumthani, Thailand<sup>b</sup> Department of Stem Cell Transplant and Cellular Therapy, The University of Texas MD Anderson Cancer Center, Houston, Texas

**A**

DSA: No	98	96	27	4	4	3	3
DSA: Yes	22	22	11	6	5	4	4

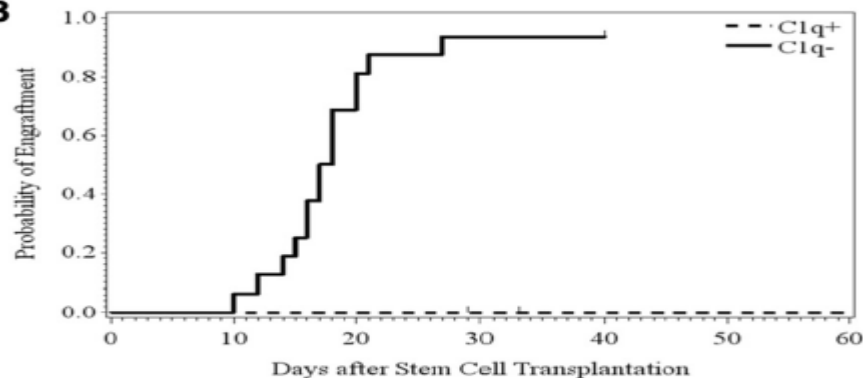
96%

68%

DSA, ANY MFI  
(MFI>5000: 46%)

HAPLO-IDENTICAL  
PT-CY BMT (112 pts)

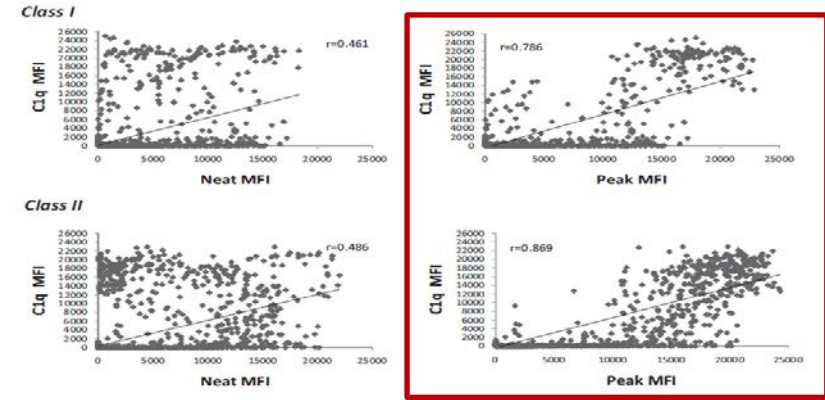
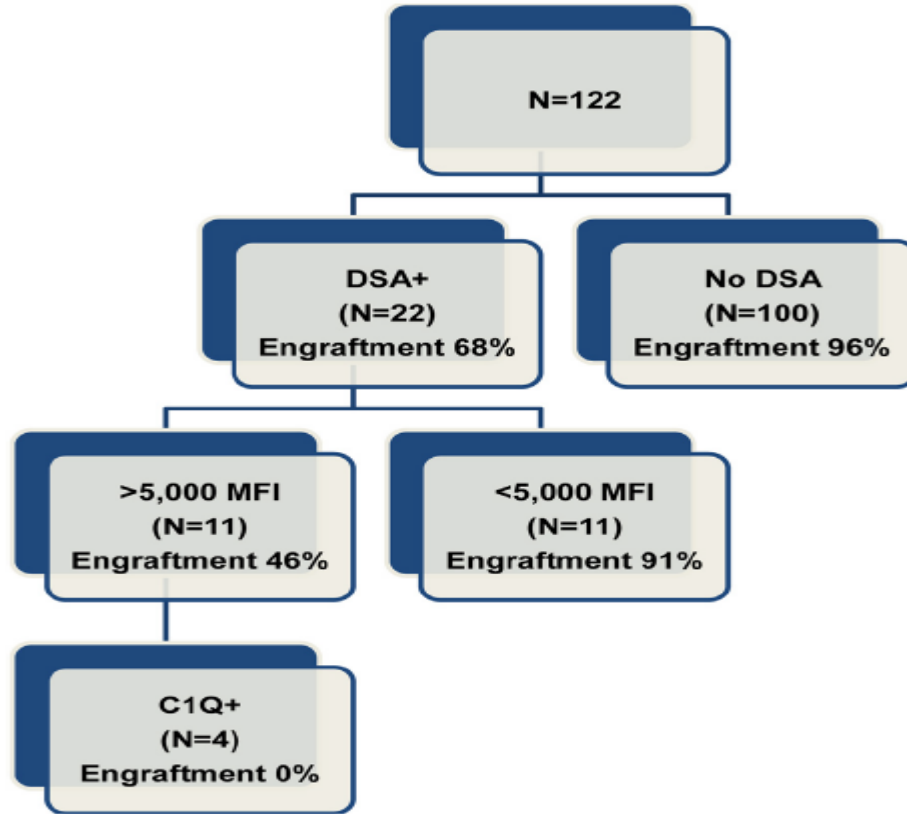
C1q POSITIVE

**B**

C1q+	5	5	5	4	3	3	3
C1q-	16	16	5	1	1	0	0

**Figure 1.** Probability of engraftment in patients by DSA status (A) and C1q status (B).

Ciurea, BBMT 2015



$r=0.486$

$r=0.869$

C1q vs. MFI

“peak” MFI after serum dilution

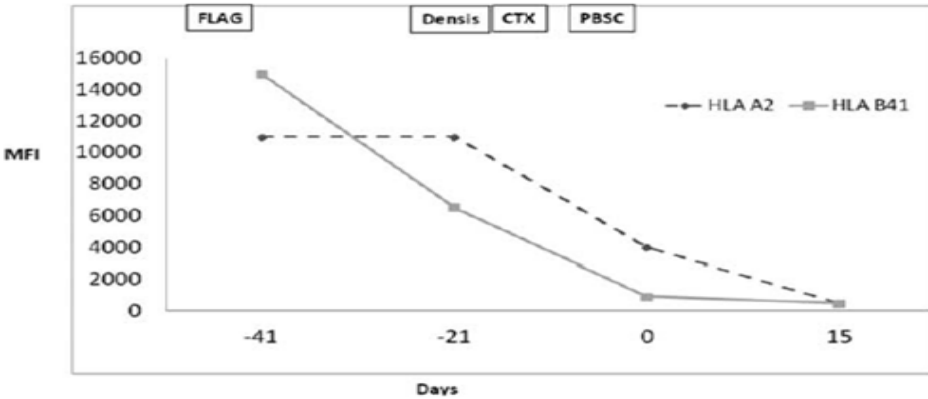
Tambur, AJT 2015

Figure 4. Diagram illustrating the decrease in rate of engraftment for all patients based on DSA and C1q status identified at the time of initial testing.

Ciurea, BBMT 2015

## Desensitization with plasma exchange in a patient with human leukocyte antigen donor-specific antibodies before T-cell-replete haploidentical transplantation

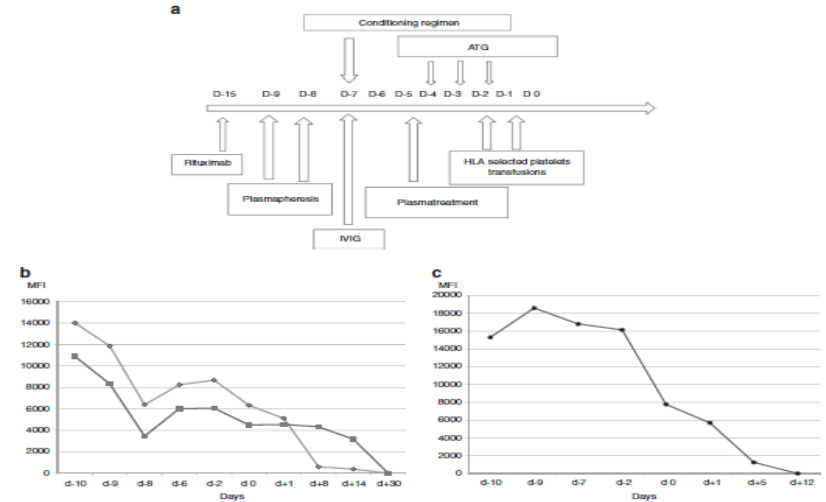
Stefania Bramanti,<sup>1</sup> Angela Nocco,<sup>2</sup> Elisa Mauro,<sup>3</sup> Giuseppe Milone,<sup>3</sup> Lucio Morabito,<sup>1</sup> Barbara Sarina,<sup>1</sup> Roberto Crocchiolo,<sup>1</sup> Inna Timofeeva,<sup>1</sup> Rossana Capizzuto,<sup>1</sup> Carmelo Carlo-Stella,<sup>4</sup> Armando Santoro,<sup>4</sup> and Luca Castagna<sup>1</sup>



Bramanti, Transfusion 2016

## Anti-HLA donor-specific antibodies in allogeneic stem cell transplantation: management and desensitization protocol

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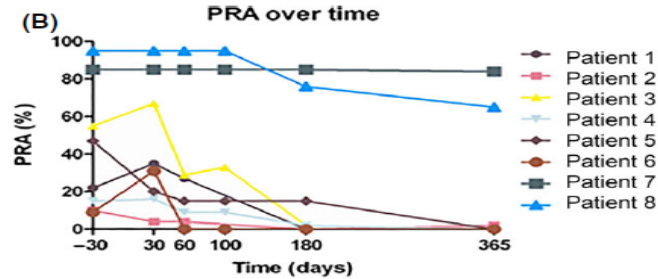
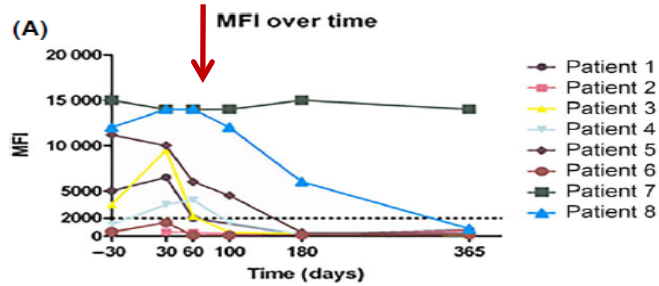


La Rocca, BMT 2019

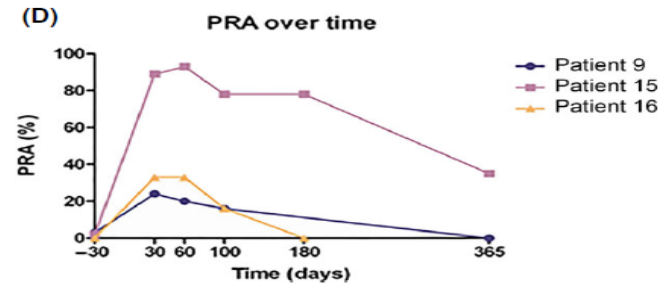
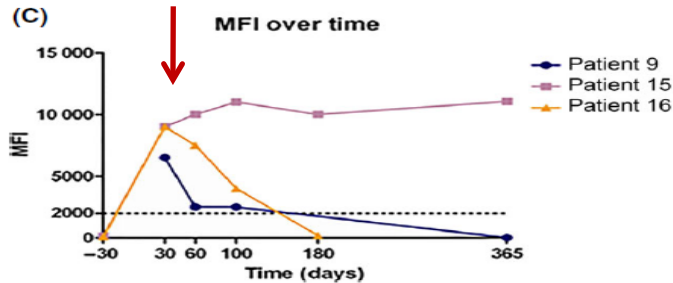
## BSHI GUIDELINE #6

HLA ALLOANTIBODY TESTING SHOULD BE  
PERFORMED IN CASES OF FAILED  
ENGRAFTMENT IF THE DONOR IS HLA  
MISMATCHED (GRADE 1B)

*dnDSA: non dire gatto.....*



Persistent DSA



De-Novo DSA

Persistence of recipient human leucocyte antigen (HLA) antibodies and production of donor HLA antibodies following reduced intensity allogeneic haematopoietic stem cell transplantation

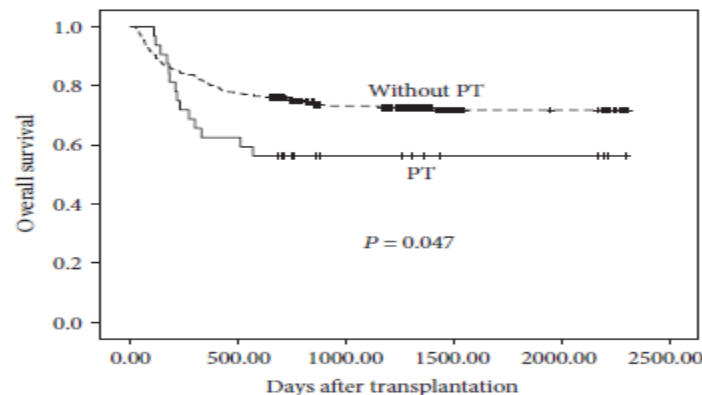
# Donor-Specific Anti-Human Leukocyte Antigen Antibodies Predict **Prolonged Isolated Thrombocytopenia** and Inferior Outcomes of Haploidentical Hematopoietic Stem Cell Transplantation

TABLE 2: The HLA-antibodies and DSA in different statuses of engraftment.

	Good engraftment	PT	PGF	GR
With positive anti-HLA antibody (n, %)	27/295 (9.2%)	6/32 (18.8%)	12/39 (30.8%)	4/4 (100%)
Median DSA MFI	3096	9374	4843	17214
Range of DSA MFI	504–12969	1403–18950	600–11736	3793–19948

TABLE 4: Multivariate analysis of factors associated with transplant outcomes.

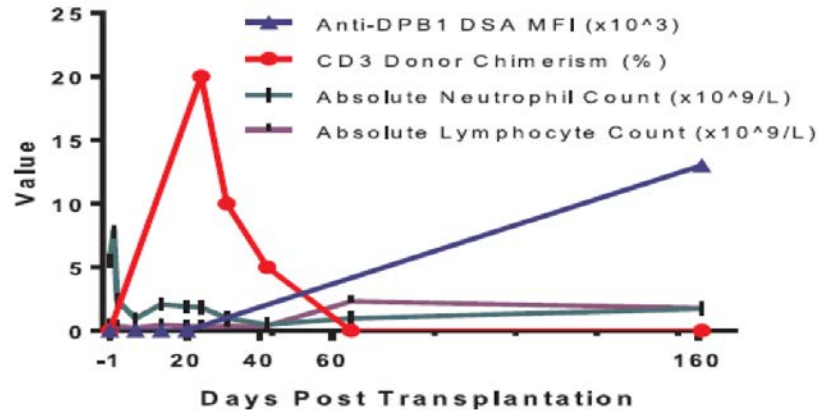
	HR	95% CI	P value
Prolonged isolated thrombocytopenia			
Infused CD34+ cells $\geq$ median	0.481	0.232–1.001	0.050
DSA			
MFI $\geq$ 1000	3.262	1.339–7.946	0.009



# Post-transplantation-emerging anti-HLA DQA1/DQB1 antibody possibly responsible for graft rejection after myeloablative-unrelated marrow grafting

Yabe, BMT 2016

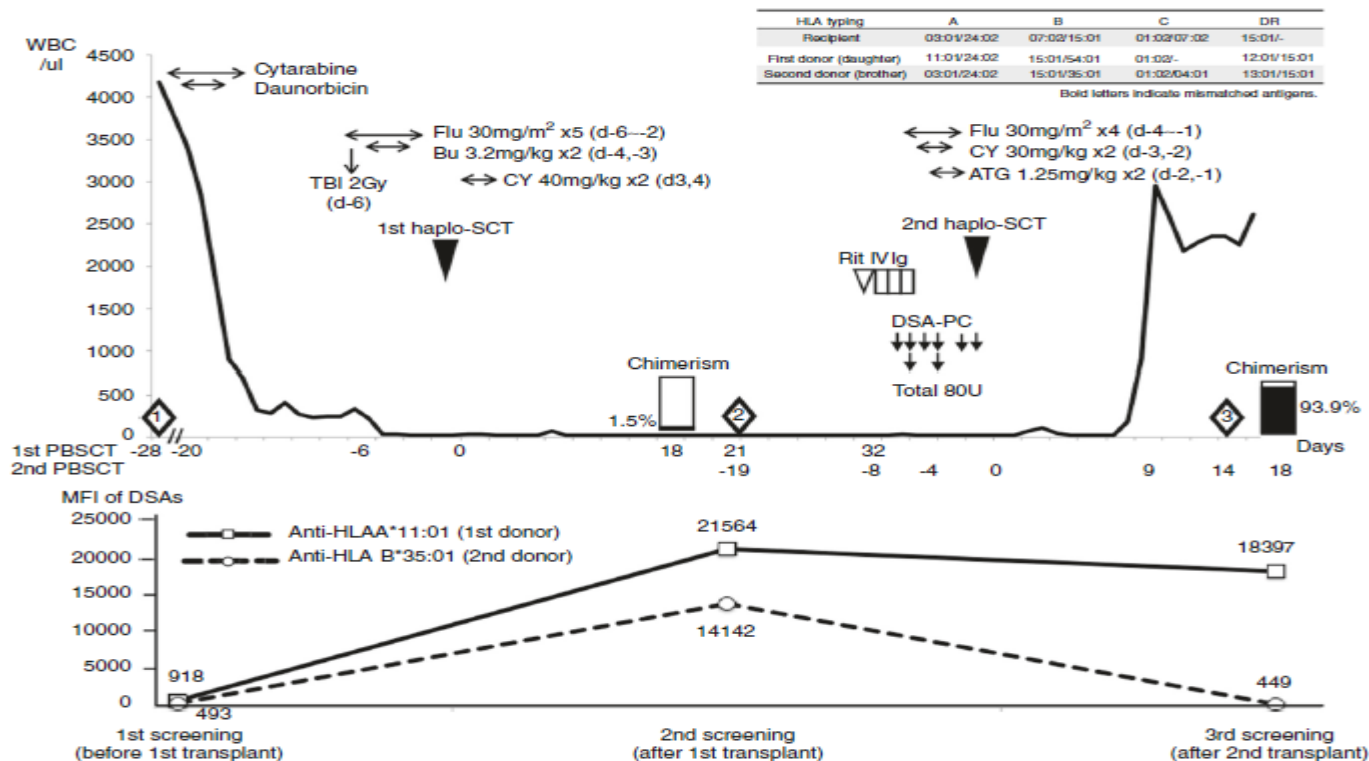
The association of de novo anti-HLA-DPB1 donor-specific antibody formation and primary graft failure after allogeneic hematopoietic cell transplantation

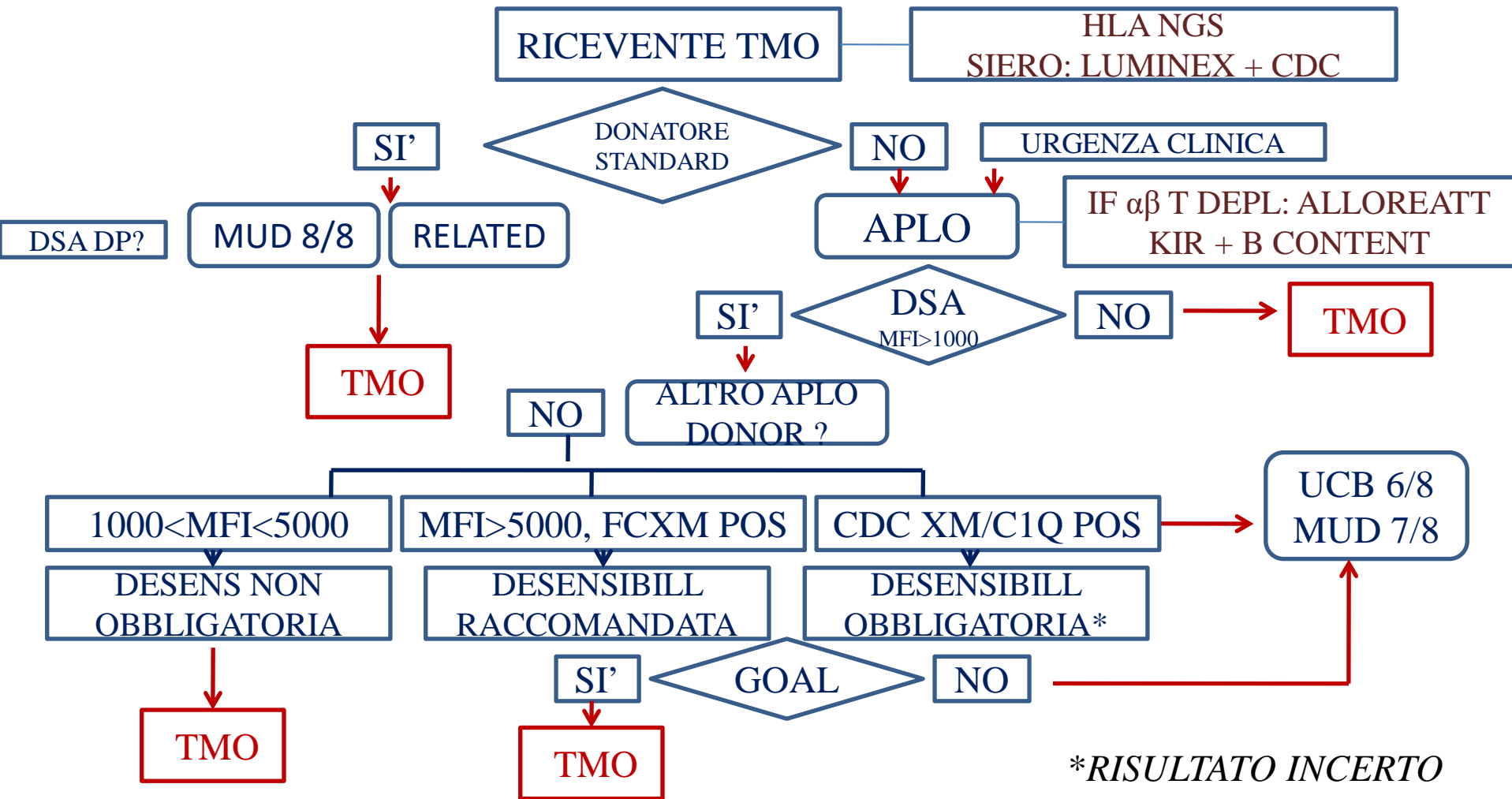


Hefazi, Hum Imm 2019



# Successful rescue transplantation with desensitization procedure after primary graft failure due to donor-specific antibody







RICCARDO



STEFANO