

## SUPPLEMENTARY MATERIAL

### *Immunologic Studies*

Flow cytometry was performed on fresh whole blood samples collected at various times after transplant. Cells were stained with a panel of directly conjugated monoclonal antibodies to identify T cells, B cells, natural killer (NK) cells, and dendritic cells (DCs), as well as functional subsets (Table S1). Labeled cells were acquired in a FACSCanto II or LSRFortessa flow cytometer (BDBiosciences) and analyzed using BD FACSDiva™ (BD Biosciences) using standard gating strategies (**Figures S1-2**).

**Table S1. Conjugated monoclonal Antibodies. \* Antibodies used for Lineage**

<b>Tube</b>	<b>Antibody</b>	<b>Brand</b>	<b>Catalogue #</b>	<b>Clone</b>
<b>T cells</b>	CD45RO FITC	BD	555492	UCHL1
	CD279 PD-1 PE	eBio	12-2799-42	eBioJ105
	CD127 PE Cy5	eBio	15-1278-42	eBioRDR5
	CD25 PE Cy7	BD	557741	M-A251
	CD62L APC	BD	559772	DREG-56
	CD4 APC-H7	BD	560158	RPA-T4
	CD3 Pac Blue (V450)	BD	560365	UCHT1
	CD8 BV510	BioLegend	301047	RPA-T8
	<b>B cells</b>	CD268 BAFF R FITC	eBio	11-9117-42
IgD PE		BD	555779	IA6-2
CD27 PE Cy5		eBio	15-0279-42	O323
CD38 PE Cy7		BD	560677	HIT2
CD19 APC		BD	555415	HIB19
CD20 APC H7		BD	560734	2H7
CD5 Pac Blue (V450)		BD	561154	UCHT2
CD45 BV510		BD	563204	HI30
<b>NK cells</b>		CD16 FITC	BD	555406
	CD56 PE	BD	555516	B159
	CD8 PE Cy7	BD	557746	RPA-T8
	NKG2D APC	BD	558071	1D11
	CD45 APC H7	BD	560178	2D1
	CD3 Pac Blue (V450)	BD	560365	UCHT1
	CD4 BV510	BD	562970	SK3
<b>Dendritic cells</b>	CD123 FITC	Miltenyi Biotec	130-090-897	AC145
	CD141 PE	BD	559781	1A4
	CD11c PE Cy5	BD	551077	B-ly6
	CD3 PE Cy7*	BD	557851	SK7
	CD19 PE Cy7*	BD	341093	SJ25C1
	CD56 PE Cy7*	BD	557747	B159
	CD14 PE Cy7*	BD	557742	M5E2
	CD86 APC	BD	555660	2331 (FUN-1)
	CD45 APC H7	BD	560178	2D1
	CD14 Pac Blue (V450)	BD	560349	MphiP9
	HLA-DR BV510	BD	563083	G46-6

**Table S2. Multivariable Cox model for OS and PFS for all subjects (N=108)**

	OS				PFS			
	HR	95% CI		p-value	HR	95% CI		p-value
Targeted therapy vs CIT	0.35	0.13	0.97	0.043	0.47	0.22	1.03	0.06
Age	1.04	0.98	1.10	0.20	1.03	0.99	1.08	0.17
Male recipient & Female donor	1.51	0.60	3.75	0.38	2.28	1.14	4.56	0.02
Number of prior therapies	1.12	0.93	1.34	0.24	1.00	0.86	1.17	0.97
HCT comorbidity score	1.18	0.99	1.42	0.067	1.17	1.01	1.36	0.036
Non-busulfan based conditioning regimen	5.10	1.14	22.8	0.033	4.22	1.03	17.2	0.045
<=7/8 HLA match vs. 8/8 match	1.50	0.48	4.70	0.48	0.87	0.31	2.46	0.79
Relapsed/refractory disease status	3.79	0.71	20.2	0.12	1.62	0.37	7.13	0.52
Richter's transformation	3.62	1.01	12.9	0.048	3.97	1.50	10.5	0.005

CIT: chemoimmunotherapy. Age, number of prior therapies, and HCT comorbidity were included as continuous variables. Flu/BU1 and Flu/BU2 were collapsed as they were not different in hazard ratio. CR and PR were also collapsed for the interest of power since they were not different in hazard ratio.

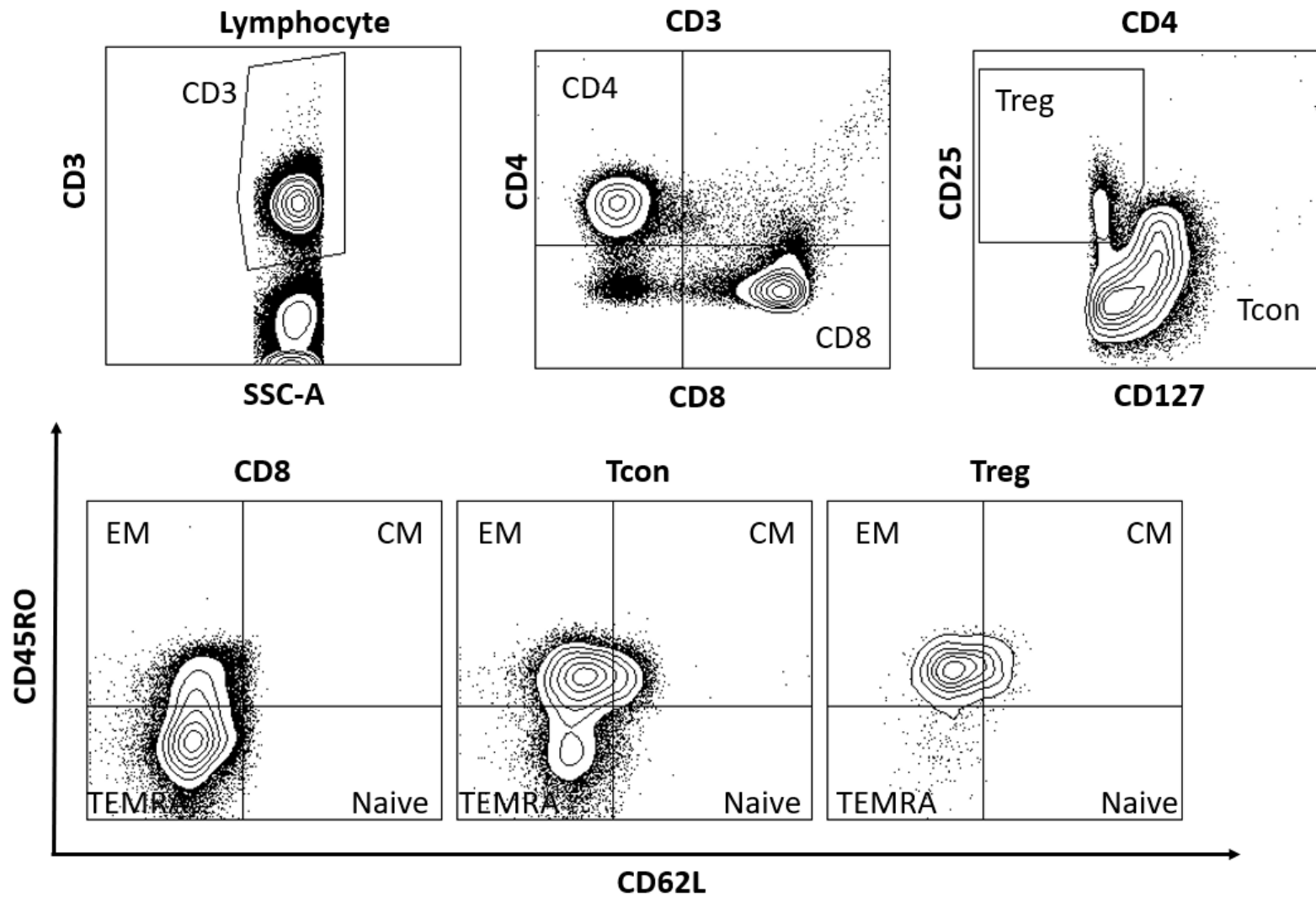
**Table S3. List of post HCT therapy**

Targeted therapy prior to HCT	Other Therapy prior to HCT	post HCT therapy
None	1.FR 2. FR 3. BR	Radiation
None	1. FR 2. Rituxan+ solumedrol	IBR/Idela+Ofa/R-CHOP
None	1. FCR	Campath
None	1. FR 2. Campath 3. Bendamustine	Radiation
None	1. FCR 2. FC 3. Rituxan/High Dose solumedrol 4. Flavopiridol x 4	Rituximab
None	1. Fludarabine 2. Fludarabine 3. Rituxan 4. Rituxan, Cytozan, Decadron 5. Rituxan, Cytozan, Decadron 6. CHOP 7. Rituxan, Campath 8. Rituxan solumedrol 9. Flavopiridol	Campath/HDMP
None	1. FCR 2. FCR	Ibrutinib
None	1. RCHOP x 8 2. Radiation to neck 3. FRx6 4. FR 5. BR	Ibrutinib
None	1. FCR 2. Rutxan 3 .R-Solumedrol	Ibrutinib
None	1. FR 2. FR 3. BR	Rituxan/Ibrutinib
None	1. FC 2. Rituxan 3. Ofatumumab HDMP Alemtuzumab	Rituxan/R-CHOP/R-ICE
None	1. ofatumumab Highdose solumedrol, Campath	Ibrutinib
None	1. FR x 6 2. BR x 6 3. Solumedrol/ Rituxan	Ibrutinib
None	1.FR 2. Radiation 3. BR	ibrutinib
None	1. ofatumumab HDMP alemtuzumab	Ibrutinib
None*	1. ofatumumab HDMP alemtuzumab	ibrutinib/Ipilimumab
None	1. FCR 2. BR 3. HDMP + Ofa 4. Ofa +alemtuzumab	ipilimumab
Venetoclax*	1. FCR 2. BR 3.FCR 4. BR 5.Ofa+HDMP+Alemtuzumab 6. ABT 199	Ibrutinib/R-CHOP
Ibrutinib*	1. FR 2. FCR 3. Ibrutinib	R-CHOP/DLI
Venetoclax	1. ofatumumab HDMP alemtuzumab	ibrutinib
Ibrutinib/CART19/Ibrutinib/Venetoclax	1. Revlimid 2. RCHOP	venetoclax continuous
Ibrutinib	1. FCR x6 2. Rituximab + Ibrutinib	Ibrutinib
Ibrutinib	1. Obinutuzumab	venetoclax

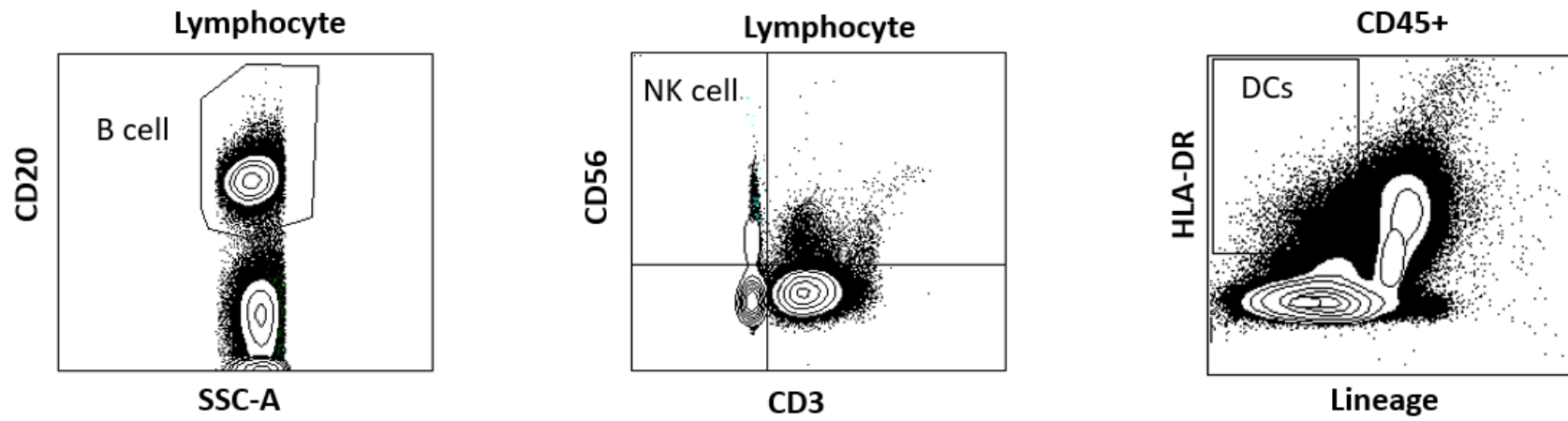
F: Fludarabine, C: cyclophosphamide, R: Rituxan, B: Bendamustine, CHOP: cyclophosphamide+doxorubicin+vincristine+prednisone, HDMP: high-dose methylprednisolone, ICE: ifosfamide+carboplatin+etoposide, DLI: donor lymphocyte infusion

\*: these patients had Richter's Transformation

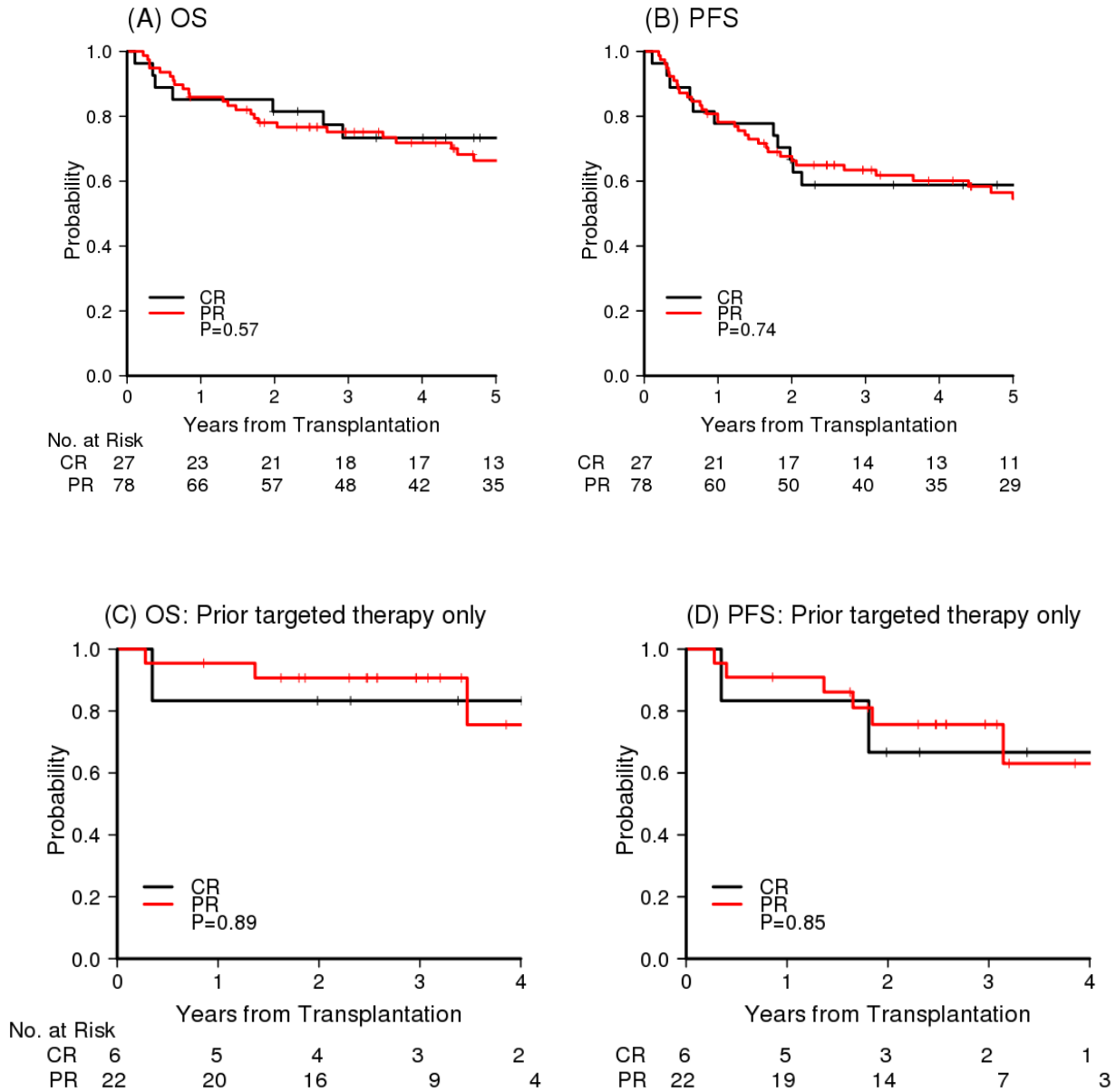
**Figure S1.** Gating strategy for analysis of T cell subsets



**Figure S2.** Gating strategy for analysis of B, NK and Dendritic cells (DCs). Lineage cocktail includes CD3, CD56, CD14 and CD19 antibodies conjugated to the same fluorescence marker.



**Figure S3.** (A) OS and (B) PFS according to the disease status for combined cohorts (N=105). Three patients who had relapsed or refractory at alloHCT were excluded. (C) OS and (D) PFS according to the disease status for the prior targeted therapy cohort (N=28). Two patients who had relapsed or refractory at alloHCT were excluded



**Figure S4.** Immune reconstitution over time for patients who received Flu/BU2 only. \* denotes p-value <0.05 and \*\* denotes p-value <0.01 for the comparison between two cohorts.

