

Supplementary Materials

Association of CD8⁺ T lymphocyte repertoire spreading with the severity of DRESS syndrome

Jun Niu^{1#}, Qingzhu Jia^{2,3#}, Qingshan Ni^{2,3}, Yi Yang^{2,3}, Gang Chen^{2,3}, Xichuan Yang¹, Zhifang Zhai¹, Haili Yu^{2,3}, Peng Guan^{2,3}, Regina Lin⁴, Zhiqiang Song¹, Qi-Jing Li^{3,4}, Fei Hao^{1*}, Hua Zhong^{1*}, Ying Wan^{2,3*}

¹Department of Dermatology, Southwest Hospital, Third Military Medical University, Chongqing, China

²Biomedical Analysis Center, Third Military Medical University, Chongqing, China

³Chongqing Key Laboratory of Cytomics, Chongqing, China

⁴Department of Immunology, Duke University Medical Center, Durham, North Carolina, USA

#Jun Niu and Qingzhu Jia contributed equally as co-first authors.

*Fei Hao, Hua Zhong, and Ying Wan are co-corresponding authors.

Sampling of peripheral blood

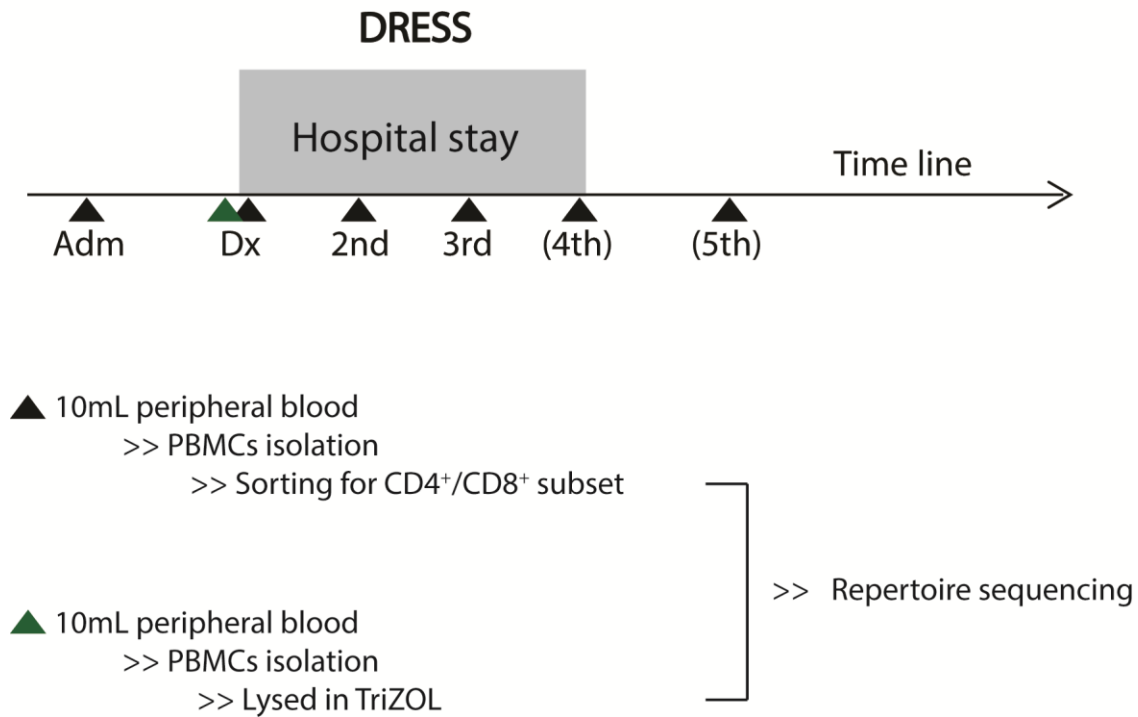


Figure-S1. Patients and sample procurement

Schematic view of collection of blood samples from DRESS patients. Grey areas show the duration of hospital stay. Adm, administration of the culprit drug; Dx, diagnosis; brackets, sampling from only certain patients. Black triangle, sampling for sorting of CD4⁺/CD8⁺ T-cell subset. Green triangle, sampling for PBMC sequencing.

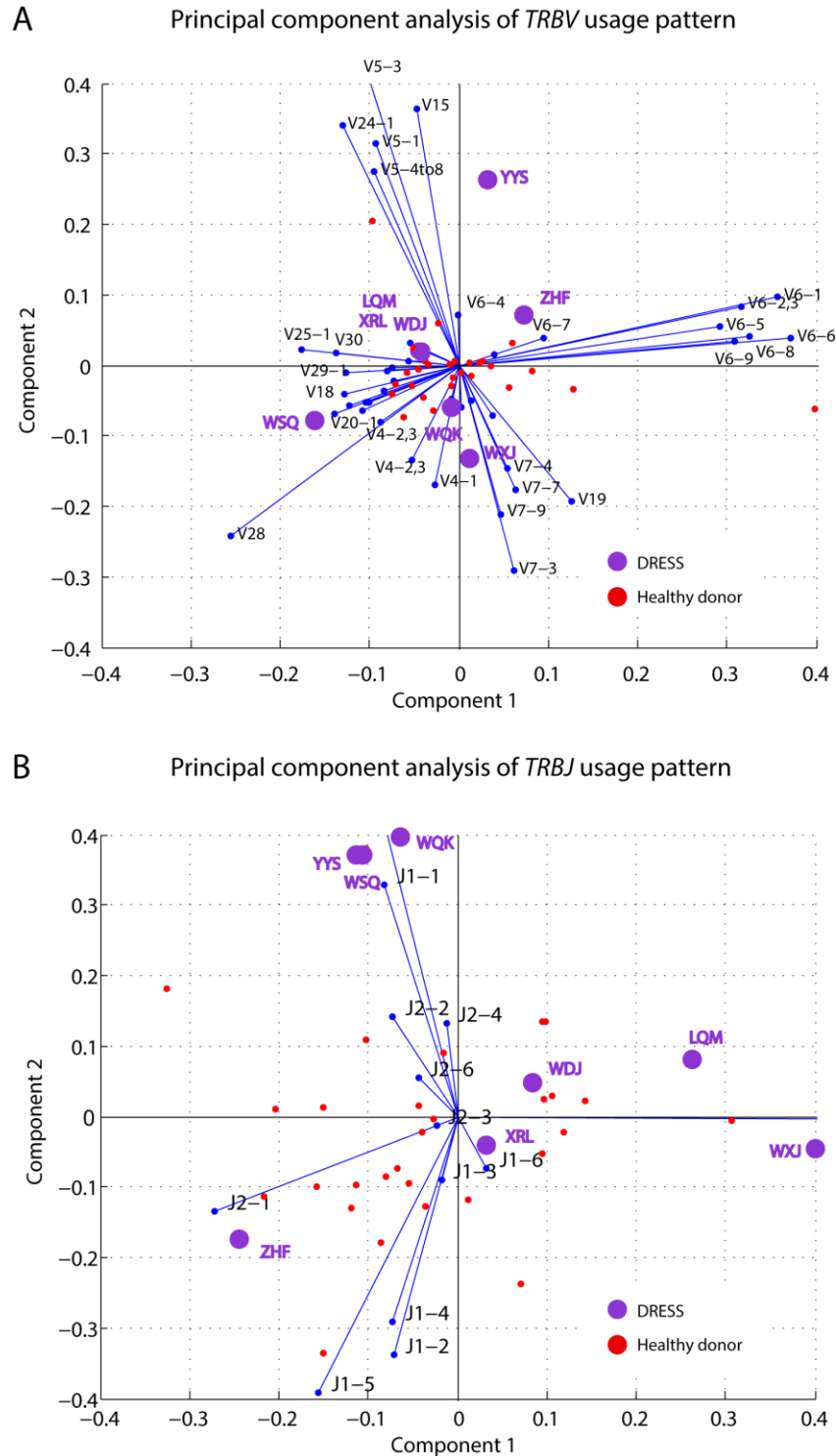


Figure-S2. *TRBV* and *TRBJ* segment usage patterns

Principal component analysis showed the overall usage patterns of (A) *TRBV* and (B) *TRBJ* segments for patients with DRESS and healthy donors. The scatterplot helps to visualize both the principal component coefficients for each gene segment and the principal component scores for each patient. The purple and red dots represent the PBMC repertoires from patients with DRESS and from healthy donors, respectively. Parts of the label for the V-beta segment were deleted to improve visual clarity.

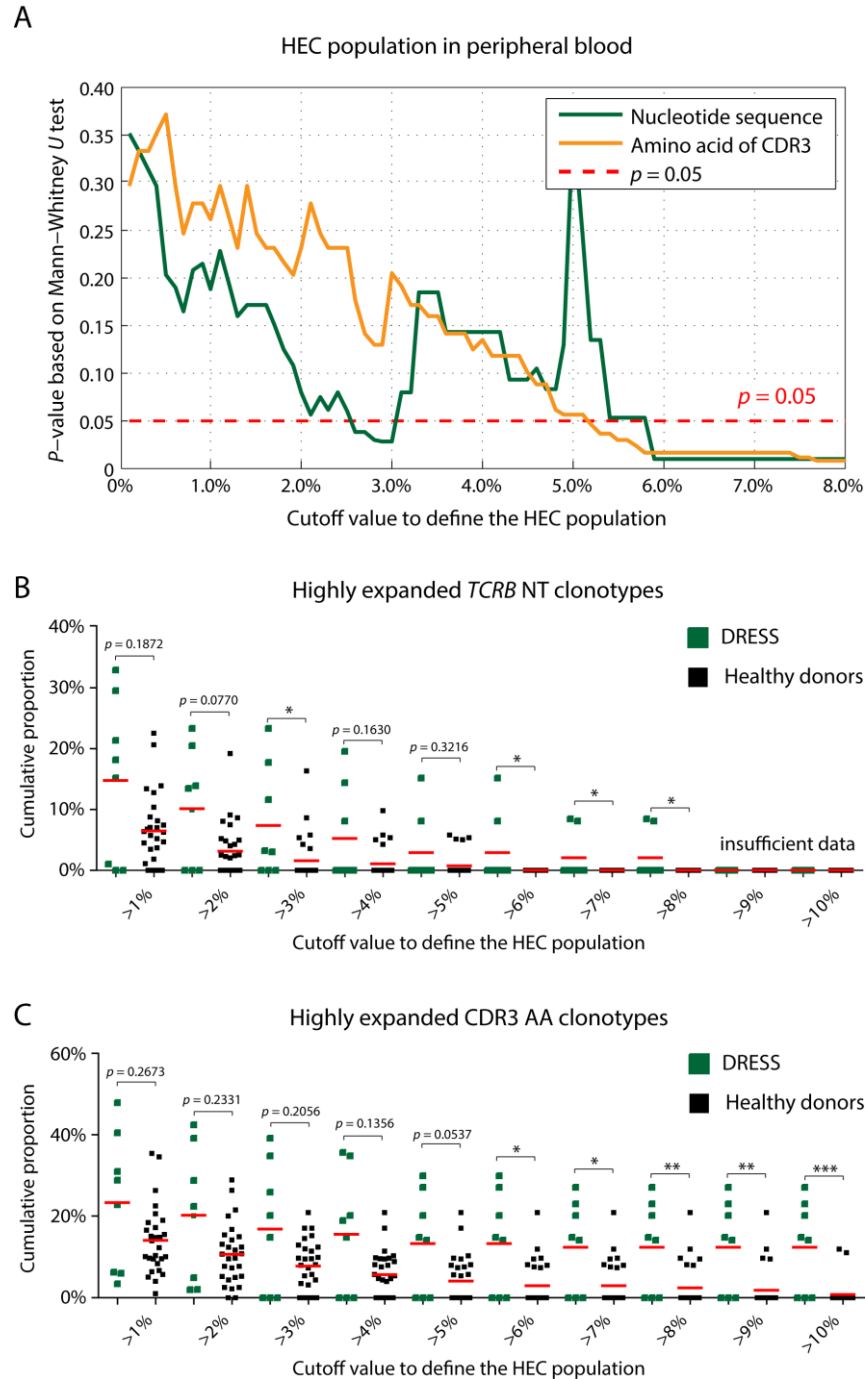


Figure-S3. Accumulation of highly expanded clonotypes in DRESS patients

(A) Mann–Whitney *U*-tests were used to compare the proportions of highly expanded clones (HECs) in patients and healthy donors. Significance of increased HECs in DRESS patients is represented as the *p*-value of the hypothesis test against the cutoff percentage that defined this HEC population. Calculation was performed for both the *TCRB* NT clones (defined as the T-cell population in which the nucleotide sequences in the entire *TCRB* transcript were identical) and for the CDR3 AA clones (defined as the T-cell population in which the amino acid sequence in the CDR3 region were identical). (B, C) Comparison of the proportion of expanded clones for both *TCRB* NT and CDR3 AA clones. Cutoff values for defining the HEC population are indicated on the horizontal axis (at intervals at 1%). Red bars, median values. Statistics based on Mann–Whitney *U*-tests.

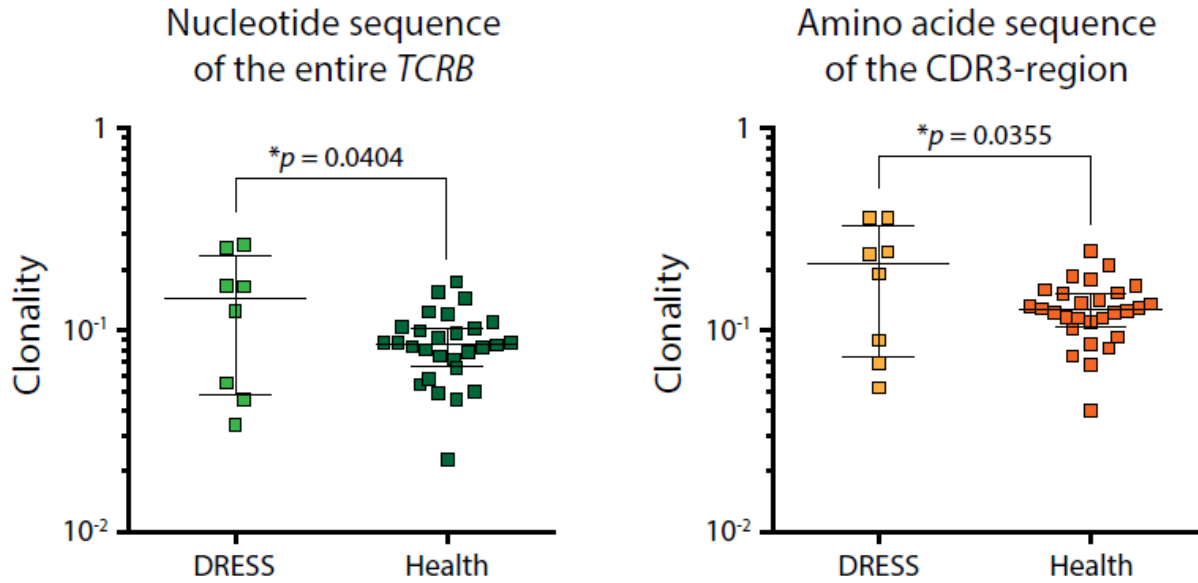


Figure-S4. Oligo-clonality of repertoire from peripheral blood

Dot plots showed the clonality index for DRESS cohort and condition-matched healthy donors. Higher index value, significant oligo-clonality; lower index value, prefer to poly-clonality. Left panel, for nucleotide sequence in the entire TCRB locus; right panel, for the amino acid sequence in CDR3 region.

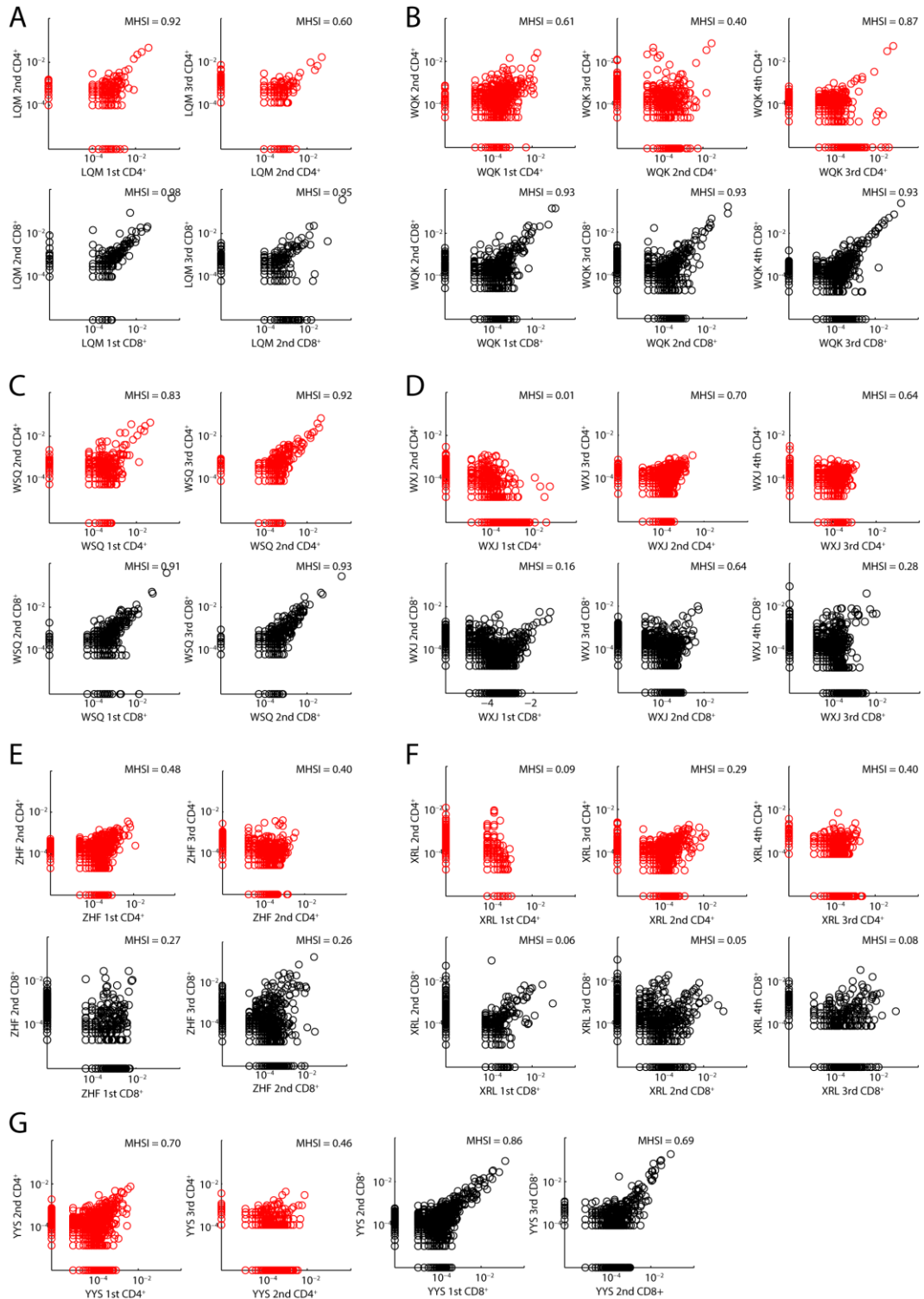


Figure-S5. Repertoire reformation during course of DRESS

Scatterplot showing the dynamic repertoire change for CD4⁺ (red dots) and CD8⁺ (black dots) T-cell clones. **(A-G)** Each dot represents a unique CDR3 AA clone and the corresponding abundance in 2 blood samples from adjacent time points. The dots on the axis indicate the clonotypes detected within a single repertoire. The MHSI is shown in the upper right corner for each panel.

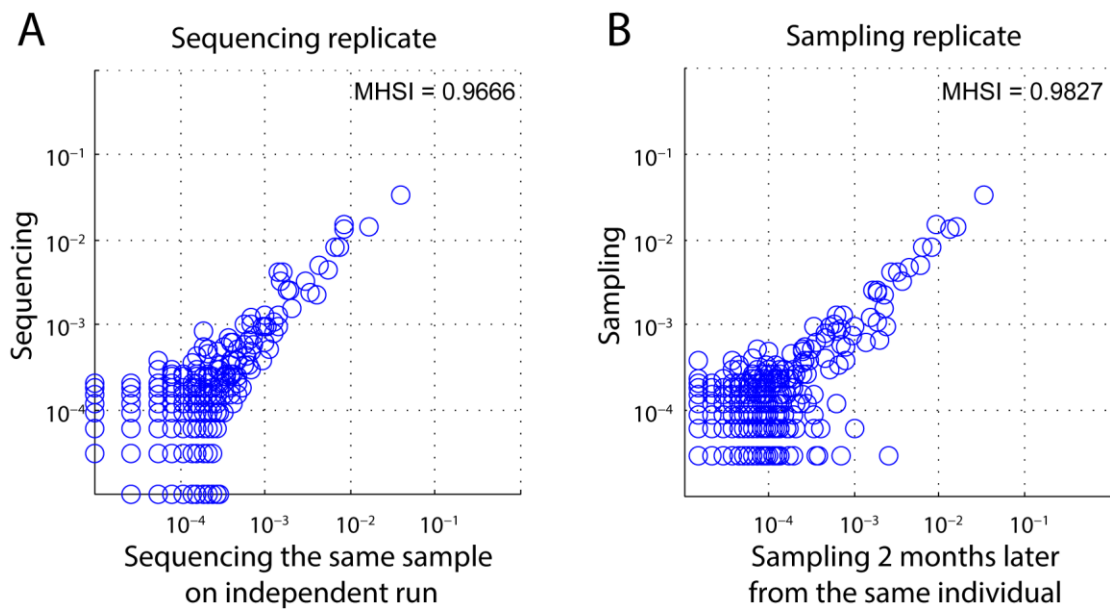


Figure-S6. Feasibility of sequencing strategy

Quality-control experiment to validate the reproducibility of our sequencing strategy. **(A)** Reproducibility of sequencing replicate. Peripheral blood mononuclear cells (PBMCs) were isolated from peripheral blood (10mL) obtained from a healthy donor for library construction. This library was sequenced twice independently to show the reproducibility of CDR3 AA clones. **(B)** Reproducibility of sampling replicates. PBMCs from an additional 10mL of peripheral blood were obtained from the same healthy donor at 57 days after the first sampling. The library was constructed and sequenced using the same protocol. The donor had no evidence of any immune-challenge, such as infections or medication, during this sampling interval. MHSI was calculated and shown in the upper right corner for each panel.

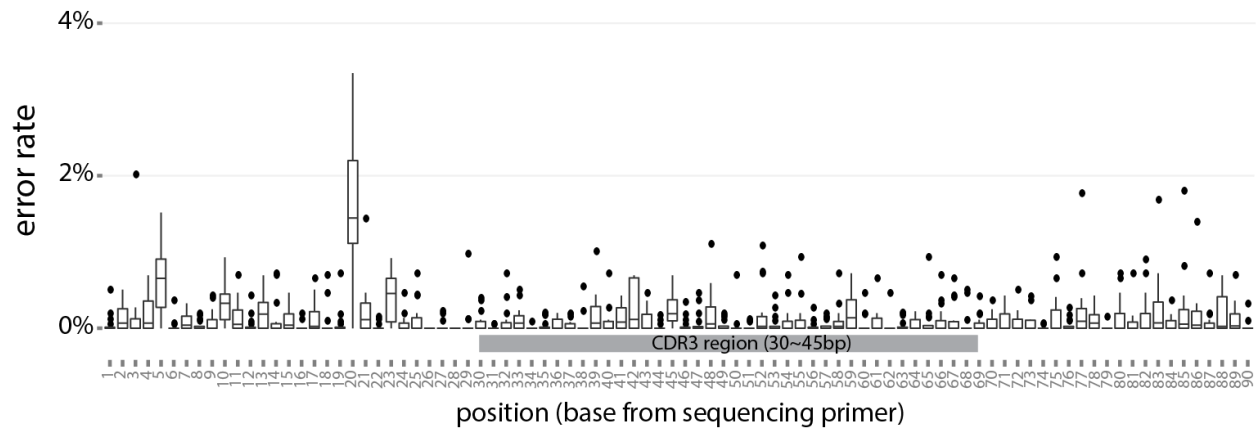


Figure-S7. Estimation of sequencing error rate

Error rate was estimated for sequencing reads covering the entire CDR3 region. 56 distinct PCR products were cloned into T-vector as standard template, and, sequenced independently according to identical protocol in this project. Box plot illustrated the distribution of error rate for each standard template in certain position. The overall error rate was 0.16% in the sequencing reads and 0.14% in CDR3 region.

Table-S1. Clinical and biological features of eight DRESS patients (at the time point of diagnosis).

	LQM	WDJ	WQK	WSQ	WXJ	XRL	YYS	ZHF
Age/gender	40/F	47/M	50/M	71/M	51/F	19/F	73/M	63/F
Drugs	1	2	1	1	3	4	5	6
Fever ≥ 38.5°C	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Enlarged lymph nodes	Yes	Yes	Yes	No/U	Yes	Yes	No/U	Yes
Eosinophilia	Yes	Yes	No/U	Yes	Yes	Yes	Yes	No/U
Atypical lymphocytes	Yes	No/U	No/U	No/U	No/U	No/U	No/U	No/U
Skin involvement								
Skin rash extent (% of skin area)	>50%	>50%	<50%	>50%	>50%	>50%	>50%	>50%
Skin rash suggesting DRESS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Biopsy suggesting DRESS	Yes	No/U	No/U	No/U	No/U	No/U	No/U	No/U
Organ involvement								
Liver	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kidney	No/U	Yes	Yes	No/U	No/U	No/U	No/U	No/U
Muscle/heart	No/U	No/U	Yes	No/U	Yes	No/U	Yes	No/U
Pancreas	No/U	No/U	No/U	No/U	No/U	No/U	No/U	No/U
Other organ	Yes	Yes	No/U	No/U	Yes	Yes	No/U	No/U
Resolution ≥ 15 days	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Evaluation of other potential causes								
Antinuclear antibody	Yes	No/U	No/U	No/U	No/U	No/U	No/U	No/U
Blood culture	No/U	No/U	No/U	No/U	No/U	No/U	No/U	No/U
Serology for HAV/HBV/HCV	No/U	No/U	No/U	No/U	No/U	No/U	No/U	No/U
Chlamydia/mycoplasma	No/U	No/U	No/U	No/U	No/U	No/U	No/U	No/U
RegiSCAR score	7	7	5	5	6	7	5	7
Karnofsky score	70%	40%	70%	70%	50%	40%	60%	40%

Drugs:

1. Antibiotics
2. Allopurinol
3. Traditional Chinese Medicine
4. Lamotrigine
5. Carbamazepine
6. Sulfasalazine

Table-S2. Human leukocyte antigen (HLA) typing of patients with DRESS

Patient	HLA-A*	HLA-B*	HLA-C*	HLA-DRB1*	HLA-DQB1*	HLA-DPB1*
LQM	A*02:03:01	B*13:01:01	C*03:04:01	DRB1*16:02:01	DQB1*05:02:01	DPB1*05:01:01G
	A*11:01:01	B*15:02:01	C*08:01:01G	DRB1*16:02:01	DQB1*05:02:01	DPB1*05:01:01G
WDJ	A*24:02	B*13:02:01	C*03:02	DRB1*07:01:01	DQB1*02:01:01	DPB1*02:01:02G
	A*30:01:01	B*58:01:01	C*06:02:01G	DRB1*13:02:01	DQB1*06:09:01	DPB1*02:01:02G
WQK	A*24:02	B*15:27:01	C*03:04:01	DRB1*04:05:01	DQB1*03:01:01	DPB1*05:01:01G
	A*24:02	B*40:01	C*04:01:01G	DRB1*11:01:01	DQB1*04:01:01	DPB1*13:01:01G
WSQ	A*02:07:01	B*46:01:01	C*01:02:01G	DRB1*14:04	DQB1*05:02:01	DPB1*02:01:02G
	A*03:01:01	B*51:01:01	C*14:02:01	DRB1*16:02:01	DQB1*05:03:01	DPB1*05:01:01G
WXJ	A*02:07:01	B*15:02:01	C*01:02:01G	DRB1*09:01:02	DQB1*03:01:01	DPB1*02:02
	A*24:02	B*46:01:01	C*08:01:01G	DRB1*12:02:01	DQB1*03:03:02	DPB1*02:02
XRL	A*11:01:01	B*13:01:01	C*03:04:01	DRB1*15:01	DQB1*06:01:01	DPB1*05:01:01G
	A*11:01:01	B*13:01:01	C*03:04:01	DRB1*15:01	DQB1*06:01:01	DPB1*14:01
YYS	A*11:01:01	B*08:01	C*03:04:01	DRB1*09:01:02	DQB1*03:03:02	DPB1*02:01:02G
	A*24:02	B*13:01:01	C*07:02:01G	DRB1*13:02:01	DQB1*06:04:01	DPB1*05:01:01G
ZHF	A*11:01:01	B*13:01:01	C*07:02:01G	DRB1*12:02:01	DQB1*03:01:01	DPB1*05:01:01G
	A*11:01:01	B*15:02:01	C*08:01:01G	DRB1*13:12:01	DQB1*03:01:01	DPB1*05:01:01G

Table-S3. Summary of sequencing

Patients	Sampling	Compartment	Reads	Unique TCRB NT clones	Unique CDR3 AA clones
LQM	First	CD4+	10205	7803	5796
		CD8+	10449	3218	2292
		PBMC	21063	17272	15538
	Second	CD4+	9513	7291	5585
		CD8+	10274	2835	1917
	Third	CD4+	7464	6096	4866
CD8+		16012	7528	5244	
WDJ	First	CD4+	49196	28685	16601
		CD8+	63599	20810	9435
		PBMC	32132	24513	21314
	Second	CD4+	64836	44988	32562
		CD8+	95138	32449	17988
	Third	CD4+	42660	32836	25229
		CD8+	41827	14816	9761
	Forth	CD4+	58632	40017	29664
		CD8+	42551	9884	3866
	Fifth	CD4+	126374	81816	63147
		CD8+	36184	12384	8723
	WQK	First	CD4+	42341	25907
CD8+			47034	18895	14060
PBMC			30088	17351	16063
Second		CD4+	40572	29517	22221
		CD8+	36808	11980	6945
Third		CD4+	39755	19505	12508
		CD8+	48155	13688	7086
Forth		CD4+	60794	38604	23073
		CD8+	53545	12646	6481
WSQ		First	CD4+	15277	10725
	CD8+		20236	10911	8850
	PBMC		17558	6916	4679
	Second	CD4+	17264	11294	8635
		CD8+	17776	5496	3756
	Third	CD4+	11596	7406	5543
CD8+		15560	5576	3790	
WXJ	First	CD4+	67134	20205	9023
		CD8+	85472	27975	14450
		PBMC	54080	20716	16394
	Second	CD4+	68129	46737	29525
		CD8+	55181	38607	25906
	Third	CD4+	48242	37826	26539
		CD8+	54170	27183	12719
	Forth	CD4+	62289	53138	43651
		CD8+	71965	36201	26143
	XRL	First	CD4+	11621	11251
CD8+			14824	11071	9549
PBMC			42873	37427	34533
Second		CD4+	61152	44894	35950

		CD8+	94622	56998	44575
	Third	CD4+	63636	51971	42574
		CD8+	65379	22589	12545
	Forth	CD4+	11221	9853	7993
		CD8+	12760	9454	6663
YYS	First	CD4+	106119	57741	26726
		CD8+	81671	23756	12385
		PBMC	56797	21731	18792
	Second	CD4+	73220	34889	14722
		CD8+	106823	35950	15790
	Third	CD4+	8290	7768	6821
		CD8+	11642	3070	2164
ZHF	First	CD4+	40048	29016	21934
		CD8+	18893	5431	2339
		PBMC	26122	15777	13086
	Second	CD4+	52990	36918	23675
		CD8+	47756	23512	12734
	Third	CD4+	38631	32496	26602
		CD8+	68936	17108	11061
Healthy Donor 01		PBMC	83356	56904	44612
Healthy Donor 02		PBMC	89660	62263	49785
Healthy Donor 03		PBMC	72983	61195	51862
Healthy Donor 04		PBMC	95828	61886	46700
Healthy Donor 05		PBMC	88744	55842	38909
Healthy Donor 06		PBMC	97239	73139	60170
Healthy Donor 07		PBMC	50024	36334	30728
Healthy Donor 08		PBMC	69501	47925	36702
Healthy Donor 09		PBMC	64891	46845	36910
Healthy Donor 10		PBMC	69883	48493	40772
Healthy Donor 11		PBMC	73451	50653	40555
Healthy Donor 12		PBMC	32074	24937	21588
Healthy Donor 13		PBMC	60295	32517	26047
Healthy Donor 14		PBMC	61029	43031	35595
Healthy Donor 15		PBMC	59184	30824	26689
Healthy Donor 16		PBMC	67278	44504	36794
Healthy Donor 17		PBMC	60091	41444	32231
Healthy Donor 18		PBMC	65424	45855	35876
Healthy Donor 19		PBMC	51556	41619	35818
Healthy Donor 20		PBMC	80494	48362	39947
Healthy Donor 21		PBMC	59422	39608	31930
Healthy Donor 22		PBMC	61518	36000	27713
Healthy Donor 23		PBMC	46552	30298	25267
Healthy Donor 24		PBMC	35508	22306	17584
Healthy Donor 25		PBMC	55941	26955	22165
Healthy Donor 26		PBMC	15743	10578	9321
Healthy Donor 27		PBMC	33172	23049	19368
Healthy Donor 28		PBMC	42544	28430	17399

Table-S4. Persistent and newly dominant clones (merged from TOP20 clone at each sampling).

Patient	Sampling					Persistent
	LQM	First	Second	Third		TCPI _{20=20/32}
'CAAAGWPPSEQY'	0.325%	0.292%	0.156%			Yes
'CAISEGDSPYEQY'	0.124%	0.117%	0.256%			Yes
'CAIESTRNQPQH'	0.105%	0.146%	0.731%			Yes
'CASSAGELF'	1.034%	1.168%	0.768%			Yes
'CASSETSGSFGTGELF'	N.D.	N.D.	0.256%			
'CASSETTVHYEGAF'	1.771%	1.197%	1.980%			Yes
'CASSFASVGNEQF'	3.168%	2.073%	0.012%			Yes
'CASSFEAGTYGYT'	0.010%	1.392%	N.D.			
'CASSISENTEAF'	0.450%	0.399%	N.D.			
'CASSLAGSTDTQY'	2.909%	1.713%	0.006%			Yes
'CASSLEQTTTRTDTQY'	0.488%	0.360%	0.181%			Yes
'CASSLETQY'	0.354%	0.467%	N.D.			
'CASSLGASYEQY'	44.789%	41.493%	33.163%			Yes
'CASSLGNEQF'	N.D.	N.D.	0.356%			
'CASSLGPPSEQY'	0.584%	0.623%	0.294%			Yes
'CASSLGQITDTQY'	0.412%	0.243%	N.D.			
'CASSLSGFGTDTQY'	0.517%	0.331%	N.D.			
'CASSLTFHQQETQY'	0.077%	0.068%	0.412%			Yes
'CASSNLGRPTYTPLSYEQY'	0.182%	0.944%	N.D.			
'CASSNPSFNQPQH'	0.364%	0.311%	0.250%			Yes
'CASSPGLPYEQY'	0.278%	0.195%	0.287%			Yes
'CASSQDEGLRHGYT'	N.D.	0.769%	0.337%			
'CASSQVASGSWGDQY'	N.D.	0.370%	0.468%			
'CASSRGQRSTDTQY'	0.134%	0.234%	0.275%			Yes
'CASSRPSGTQY'	1.589%	1.879%	2.261%			Yes
'CASSSTDPGLPYNEQF'	0.268%	0.321%	0.250%			Yes
'CASSWGPPSEQY'	1.034%	0.526%	0.593%			Yes
'CASSYAYTDTQY'	0.488%	0.088%	N.D.			
'CASSYGQGNTEAF'	0.536%	8.585%	0.418%			Yes
'CASSYSPGDPLGAF'	0.900%	0.370%	N.D.			
'CASSYSRQGSHEQY'	0.679%	0.516%	0.269%			Yes
'CSNRTGTNSGNTIY'	0.651%	1.285%	0.281%			Yes
WDJ	First	Second	Third	Fourth	Fifth	TCPI _{20=27/68}
'CAGQEREAAGELF'	0.192%	0.092%	0.146%	N.D.	1.155%	
'CAISESAGETEYQY'	0.000%	0.000%	0.000%	N.D.	0.627%	
'CAISESQTDTQY'	0.330%	0.179%	0.270%	0.099%	1.078%	Yes
'CASARDEQY'	0.024%	0.996%	1.657%	0.197%	1.354%	Yes
'CASEPRDRGWNEQF'	N.D.	N.D.	N.D.	0.282%	N.D.	
'CASGQGGDEQY'	0.035%	0.059%	0.100%	0.019%	1.727%	Yes
'CASGVTGGSTDTQY'	0.520%	0.075%	0.019%	N.D.	N.D.	

'CASREENTGELF'	2.115%	0.564%	0.416%	0.122%	0.006%	Yes
'CASRTGTSGSYEQY'	0.486%	0.060%	0.022%	N.D.	N.D.	
'CASSALGGILSYNEQF'	0.700%	0.077%	0.036%	0.012%	N.D.	
'CASSAWGNEQY'	0.006%	0.009%	0.002%	0.334%	0.503%	Yes
'CASSDINEQF'	0.014%	0.005%	N.D.	0.277%	N.D.	
'CASSEATSGSLGKETQY'	N.D.	0.562%	0.237%	N.D.	0.008%	
'CASSEEGGSGANVLT'	0.013%	0.057%	0.084%	N.D.	0.699%	
'CASSFEGPGELF'	N.D.	0.579%	0.739%	0.432%	0.229%	
'CASSFGTTNTGELF'	3.728%	1.639%	2.233%	0.219%	0.047%	Yes
'CASSFPSGSRDEQY'	N.D.	0.736%	2.149%	0.092%	0.033%	
'CASSFSSNQPQH'	0.582%	0.215%	0.182%	N.D.	0.403%	
'CASSHTGELF'	0.030%	0.117%	0.375%	0.026%	3.789%	Yes
'CASSIGAGSNQPQH'	N.D.	1.072%	1.592%	0.259%	0.055%	
'CASSLASETQY'	0.008%	2.487%	2.883%	0.879%	0.069%	Yes
'CASSLATAETQY'	0.420%	0.027%	0.029%	N.D.	N.D.	
'CASSLEQGTGELF'	0.489%	0.145%	0.201%	0.026%	0.003%	Yes
'CASSLGGQGYEQY'	N.D.	0.001%	N.D.	0.115%	3.073%	
'CASSLGLTGNEQF'	0.014%	0.269%	0.605%	0.047%	0.080%	Yes
'CASSLGMARSSYEQY'	N.D.	1.418%	1.078%	0.122%	0.265%	
'CASSLQQSQETQY'	0.681%	0.054%	0.031%	N.D.	N.D.	
'CASSLSGTNPWPYEQY'	0.011%	1.345%	2.785%	1.269%	0.354%	Yes
'CASSLTCQSSRRGYT'	0.560%	0.362%	0.244%	N.D.	N.D.	
'CASSLTINTGELF'	N.D.	0.022%	0.571%	0.115%	0.099%	
'CASSLVAGGGETQY'	N.D.	0.001%	N.D.	N.D.	0.879%	
'CASSLWGTSNYGYT'	0.017%	0.748%	1.054%	0.188%	0.061%	Yes
'CASSPFYGGYGYEQY'	N.D.	0.502%	0.598%	0.026%	0.006%	
'CASSPGENEQF'	0.042%	0.013%	N.D.	0.505%	N.D.	
'CASSPGLAEYNEQF'	1.025%	0.293%	0.215%	0.230%	0.006%	Yes
'CASSPPGLVDNEQF'	0.190%	2.142%	3.287%	2.879%	1.362%	Yes
'CASSPRRYNEQF'	N.D.	0.628%	0.693%	N.D.	0.011%	
'CASSPWTTEAF'	0.050%	0.034%	0.084%	0.148%	2.777%	Yes
'CASSQDRATGELF'	0.019%	0.027%	0.091%	0.508%	0.279%	Yes
'CASSQDTGGNQPQH'	N.D.	1.948%	4.748%	0.338%	0.083%	
'CASSQESGNTEAF'	0.168%	0.171%	0.301%	1.873%	10.488%	Yes
'CASSQLQGSNQPQH'	N.D.	N.D.	N.D.	N.D.	0.553%	
'CASSSAGGPAETQY'	0.325%	0.471%	0.751%	0.101%	0.003%	Yes
'CASSSLIAGAGNEQF'	N.D.	0.048%	0.990%	0.367%	0.122%	
'CASSSSTEAF'	0.042%	0.017%	0.022%	0.226%	0.614%	Yes
'CASSTGPSFTGELF'	0.307%	0.057%	0.088%	0.160%	9.189%	Yes
'CASSTGTSGSEQY'	N.D.	N.D.	N.D.	0.296%	N.D.	
'CASSTRQGTGYT'	5.035%	0.714%	0.404%	0.148%	0.146%	Yes
'CASSVGGLPGDEQF'	0.027%	0.011%	0.010%	N.D.	1.545%	
'CASSWKQSAGELF'	0.042%	0.063%	0.103%	0.402%	1.501%	Yes

'CASSWTSPLPDEQY'	0.008%	N.D.	N.D.	0.282%	N.D.	
'CASSYFGQGSdTQY'	0.428%	0.054%	0.038%	0.169%	0.011%	Yes
'CASSYGGSTDTQY'	0.478%	0.225%	0.232%	N.D.	N.D.	
'CASSYLGQGSdIQY'	1.299%	0.107%	0.060%	0.016%	0.008%	Yes
'CASSYMAGQPQH'	0.992%	0.503%	0.292%	N.D.	0.025%	
'CASSYNPLVYEQY'	N.D.	0.520%	0.299%	N.D.	0.019%	
'CASSYRLGTGVSNPQH'	N.D.	0.596%	0.098%	0.016%	0.006%	
'CASSYRTDPGELF'	0.362%	0.057%	0.012%	N.D.	N.D.	
'CASSYSLSFHNEQF'	N.D.	N.D.	N.D.	0.284%	N.D.	
'CASSYSRDNEQF'	N.D.	N.D.	N.D.	0.289%	N.D.	
'CASSYTPGESYEQY'	1.005%	0.279%	0.160%	N.D.	N.D.	
'CASSYVLNTEAF'	0.791%	0.148%	0.043%	N.D.	N.D.	
'CASTLDRERRSNQPQH'	0.002%	0.311%	1.050%	0.028%	1.998%	Yes
'CASTLGGNQPQH'	0.516%	0.164%	0.201%	0.054%	N.D.	
'CASTTSIYNEQF'	N.D.	0.003%	N.D.	0.303%	N.D.	
'CATKKGIEAF'	0.041%	7.662%	8.351%	0.369%	0.174%	Yes
'CATSRDTLAGAPQDTQY'	0.077%	0.037%	0.093%	0.414%	1.860%	Yes
'CSARPNEQY'	0.005%	0.015%	0.038%	N.D.	0.569%	
WQK	First	Second	Third	Fourth		TCPI_{20=25/31}
'CAIRAAGQGAYEQY'	0.848%	0.446%	0.723%	0.863%		Yes
'CASELVTGELF'	0.166%	0.312%	0.143%	0.106%		Yes
'CASGPPGFSGELF'	0.021%	0.342%	0.021%	N.D.		
'CASRGLAGTSDTQY'	0.753%	0.804%	0.239%	0.329%		Yes
'CASRLTGGSTEAF'	6.013%	2.434%	4.452%	4.988%		Yes
'CASRPPGSTYNEQF'	0.147%	0.206%	0.320%	0.317%		Yes
'CASRRRGAMETQY'	0.145%	0.149%	0.262%	0.472%		Yes
'CASSFPQVVGFPGYT'	N.D.	0.003%	0.370%	N.D.		
'CASSIGDLEQF'	0.168%	0.508%	0.075%	0.211%		Yes
'CASSLAYGQVGDGYT'	0.927%	0.937%	1.140%	1.156%		Yes
'CASSLLYFGRQNTGELF'	1.301%	1.869%	1.578%	1.686%		Yes
'CASSLRGYSNPQH'	0.381%	0.196%	0.114%	N.D.		
'CASSPEGFETQY'	12.876%	13.516%	16.628%	24.914%		Yes
'CASSPGTVYGYT'	0.336%	0.269%	0.291%	0.190%		Yes
'CASSPPGGGPKNIQY'	1.059%	1.141%	1.038%	0.872%		Yes
'CASSPRAAGLTYEQY'	0.468%	0.144%	0.143%	0.080%		Yes
'CASSPTGATEAF'	2.407%	1.986%	2.878%	3.750%		Yes
'CASSQDRRDNPQH'	8.498%	13.820%	7.978%	7.209%		Yes
'CASSQGGNLEQF'	0.600%	1.739%	1.564%	1.860%		Yes
'CASSQGGNSYEQY'	0.742%	2.154%	2.091%	2.783%		Yes
'CASSRLYPGTDPDGYT'	0.070%	0.136%	0.071%	0.437%		Yes
'CASSYGNIQY'	0.755%	0.022%	N.D.	N.D.		
'CASSYGPGHGEQY'	0.436%	0.141%	0.328%	0.321%		Yes
'CASSYGTGRTGELF'	2.326%	2.059%	2.737%	2.344%		Yes

'CASSYSGYGYT'	0.032%	0.693%	0.033%	N.D.	
'CASSYYGGRADTQY'	0.389%	0.467%	1.094%	1.255%	Yes
'CATSDLVGDTP'	N.D.	0.005%	1.560%	0.024%	
'CATSVSSGRHTGELF'	0.096%	0.120%	0.162%	0.433%	Yes
'CSARARRLAGGPDHAPDTQY'	0.525%	0.405%	0.451%	0.454%	Yes
'CSARDGIGRVGDQPQH'	0.427%	0.462%	0.469%	0.316%	Yes
'CSARVPRTGSTGNTIY'	0.512%	0.951%	0.557%	0.633%	Yes

WSQ	First	Second	Third		TCPI_{20=26/27}
'CASSAEGPGLDTPDTQY'	0.080%	0.276%	0.604%		Yes
'CASSDGRRADEQF'	0.439%	0.619%	1.202%		Yes
'CASSFSAGTGDEQF'	0.581%	0.478%	0.964%		Yes
'CASSFSGSADTQY'	0.205%	0.782%	2.892%		Yes
'CASSGTGGAETQY'	0.547%	0.349%	0.231%		Yes
'CASSLEQGARTDTQY'	0.330%	0.456%	0.611%		Yes
'CASSLETRTGELF'	1.356%	N.D.	N.D.		
'CASSLGETQY'	0.450%	0.467%	0.572%		Yes
'CASSLGQGGAPQH'	0.626%	0.456%	0.379%		Yes
'CASSLQGYNEQF'	6.071%	4.135%	4.467%		Yes
'CASSLTLTGNTAEF'	25.379%	39.351%	26.877%		Yes
'CASSPWRDSGANVLT'	0.849%	0.675%	0.649%		Yes
'CASSQESAGSAYNEQF'	0.171%	0.467%	0.334%		Yes
'CASSQSGQPQH'	0.182%	0.619%	0.649%		Yes
'CASSQKLTGELF'	0.456%	0.186%	0.418%		Yes
'CASSRGGWETQY'	0.626%	0.338%	1.015%		Yes
'CASSRLAGLADTQY'	1.190%	0.793%	1.459%		Yes
'CASSRQGAGPRETQY'	0.399%	0.596%	0.668%		Yes
'CASSRRSGSGNEQF'	1.008%	1.243%	1.324%		Yes
'CASSSLGTGGSRETQY'	0.604%	0.478%	0.656%		Yes
'CASSSWSSGTDTPDTQY'	0.370%	0.208%	0.141%		Yes
'CASSVGTSGELF'	5.245%	4.962%	3.952%		Yes
'CASSVQGAGPRETQY'	1.213%	0.467%	0.790%		Yes
'CASSYPGQEA'	0.820%	0.664%	0.559%		Yes
'CASSYSLSVGEKLF'	0.228%	0.714%	0.810%		Yes
'CASWDHSYEQY'	0.273%	0.236%	0.810%		Yes
'CATDTSGGSSSETQY'	0.427%	0.388%	0.276%		Yes

WXJ	First	Second	Third	Fourth	TCPI_{20=32/58}
'CAAETGGYEQY'	0.026%	0.005%	0.214%	N.D.	
'CASEPGLGYFAGELF'	0.371%	0.022%	0.035%	0.085%	Yes
'CASHGYSRADSGLF'	0.019%	0.312%	0.076%	N.D.	
'CASKKDLSTYEQY'	2.116%	0.544%	0.700%	0.449%	Yes
'CASKRGTGYTGELF'	0.098%	N.D.	0.006%	0.522%	
'CASLRGYREKLF'	N.D.	N.D.	N.D.	0.623%	
'CASNEDRRSSYNEQF'	0.468%	0.013%	N.D.	0.003%	

'CASNRGLSPYNEQF'	0.021%	N.D.	0.164%	N.D.	
'CASRFTSAGNEQF'	0.001%	0.045%	0.074%	0.809%	Yes
'CASRLGAAAYGYT'	0.414%	0.043%	0.140%	0.427%	Yes
'CASRMTSGRGETQY'	0.002%	0.141%	0.024%	0.076%	Yes
'CASRPTDSHQPH'	0.672%	0.105%	0.078%	0.361%	Yes
'CASRRLAGTYEQY'	0.621%	0.056%	0.159%	0.417%	Yes
'CASSALTGELF'	N.D.	N.D.	0.153%	N.D.	
'CASSDLSLAKNIQY'	N.D.	N.D.	N.D.	0.402%	
'CASSEDSMNTEAF'	0.051%	0.013%	0.151%	N.D.	
'CASSEGQGGGETQY'	0.006%	0.076%	0.024%	0.755%	Yes
'CASSETSYPNEQF'	0.008%	N.D.	0.162%	N.D.	
'CASSFLDREMETHY'	6.282%	0.533%	1.036%	0.447%	Yes
'CASSFNPLAVVEQY'	0.502%	0.036%	0.109%	0.563%	Yes
'CASSFSDRTYSYEQY'	0.001%	0.152%	0.030%	0.018%	Yes
'CASSFTGGPVEQY'	0.006%	0.004%	0.166%	N.D.	
'CASSISGISYNEQF'	5.101%	0.265%	0.541%	0.705%	Yes
'CASSLASYEQY'	1.073%	0.134%	0.135%	0.710%	Yes
'CASSLDWGAGQPQH'	0.048%	0.007%	N.D.	0.552%	
'CASSLFTGGSGNTIY'	0.551%	0.027%	0.030%	0.093%	Yes
'CASSLGGGSSYEQY'	3.064%	0.199%	0.157%	0.357%	Yes
'CASSLGLPGNNEQF'	0.051%	0.002%	0.330%	N.D.	
'CASSLIQGGGNEQF'	0.029%	0.141%	0.026%	0.813%	Yes
'CASSLQGSNTEAF'	N.D.	N.D.	N.D.	8.663%	
'CASSLVAGPAYNEQF'	0.011%	0.167%	0.028%	0.040%	Yes
'CASSLVGGKSSYEQY'	0.448%	0.040%	0.042%	0.142%	Yes
'CASSPAGVGQPQH'	0.026%	0.004%	0.246%	N.D.	
'CASSPDQDYQPQH'	0.418%	0.042%	0.030%	0.003%	Yes
'CASSPGENEQF'	0.061%	N.D.	0.183%	0.001%	
'CASSPGGAPNEQF'	0.002%	0.013%	0.009%	0.364%	Yes
'CASSPGSGFAGELF'	0.004%	0.130%	0.009%	0.015%	Yes
'CASSPYPGQGAHQPH'	N.D.	N.D.	N.D.	0.459%	
'CASSQAQGLGYT'	0.261%	0.060%	0.017%	0.721%	Yes
'CASSQEPGLAGVKDTQY'	0.834%	0.031%	0.009%	0.015%	Yes
'CASSQGLAGNEQY'	0.020%	0.004%	0.153%	N.D.	
'CASSQGTGTATGELF'	0.026%	0.397%	0.022%	0.019%	Yes
'CASSQGTSGTTGELF'	0.006%	0.256%	0.044%	0.040%	Yes
'CASSRGDVQETQY'	0.001%	0.159%	0.028%	0.017%	Yes
'CASSRSAETQY'	N.D.	0.129%	0.052%	0.028%	
'CASSTGTSGSEQY'	0.005%	0.007%	0.242%	N.D.	
'CASSVSSYNEQF'	N.D.	N.D.	N.D.	1.276%	
'CASSWTSPLDEQY'	0.030%	N.D.	0.342%	N.D.	
'CASSYGGGASYEQY'	1.598%	0.170%	0.295%	0.197%	Yes
'CASSYIGSSYNEQF'	N.D.	0.149%	0.007%	0.071%	

'CASSYLDSYGYT'	N.D.	0.201%	0.015%	0.082%	
'CASSYSEGPYGYT'	N.D.	0.109%	N.D.	0.060%	
'CASSYSTNTEAF'	0.469%	0.060%	0.017%	0.082%	Yes
'CASTMLAKNTGELF'	0.001%	0.266%	0.054%	0.033%	Yes
'CASTNDGTGNTYEQY'	0.456%	0.105%	0.384%	3.944%	Yes
'CATFKGDRKAF'	0.998%	0.060%	0.024%	0.006%	Yes
'CATRGGGGGETQY'	0.027%	0.002%	0.201%	N.D.	
'CSAPSGINYEQY'	0.553%	0.007%	0.004%	0.011%	Yes
XRL	First	Second	Third	Fourth	TCPI_{20=27/65}
'CAISEGDSPYEQY'	0.054%	N.D.	N.D.	0.408%	
'CAIESTRNQPQH'	0.155%	N.D.	N.D.	0.729%	
'CAISMDEF'	0.034%	0.015%	0.021%	0.243%	Yes
'CASGDRGFYNEQF'	N.D.	N.D.	0.474%	0.016%	
'CASGLSEGGNQPQH'	0.857%	0.420%	0.197%	0.172%	Yes
'CASIELSYSNQPQH'	0.189%	0.110%	0.044%	0.141%	Yes
'CASKAGTSVYGEQF'	N.D.	0.226%	0.018%	0.008%	
'CASKKGQGGTEAF'	N.D.	0.017%	1.256%	0.251%	
'CASLDRGLQPQH'	0.013%	0.005%	0.801%	0.227%	Yes
'CASMRTSAPDTQY'	N.D.	0.391%	0.060%	0.024%	
'CASQSRGMTF'	N.D.	N.D.	N.D.	0.329%	
'CASRDAGDYWEQY'	0.398%	0.120%	0.133%	0.110%	Yes
'CASRPGTETYEQY'	1.363%	0.023%	0.008%	N.D.	
'CASRPSRGGGYGYT'	N.D.	1.660%	0.147%	0.047%	
'CASRRDYSYNEQF'	0.007%	0.013%	0.575%	0.055%	Yes
'CASRTGTSDHEQY'	0.297%	0.367%	0.370%	0.243%	Yes
'CASSAGRMGTDTQY'	N.D.	N.D.	2.199%	0.024%	
'CASSDPYRGEPQH'	0.020%	0.012%	0.707%	0.133%	Yes
'CASSFMDRNEKLF'	N.D.	1.175%	0.116%	0.031%	
'CASSIEQNTEAF'	0.533%	0.017%	N.D.	N.D.	
'CASSLAGVGQETQY'	0.526%	0.181%	0.174%	0.102%	Yes
'CASSLDDAETDTQY'	N.D.	4.840%	0.072%	0.055%	
'CASSLEQNTEAF'	0.634%	0.010%	N.D.	N.D.	
'CASSLGQGRDTQY'	3.069%	0.632%	0.763%	1.520%	Yes
'CASSLGVTSYSEQY'	0.459%	0.012%	0.003%	N.D.	
'CASSLRLTLLNEQF'	0.040%	0.024%	0.031%	0.415%	Yes
'CASSLSGHDIYEQY'	N.D.	0.246%	0.014%	0.016%	
'CASSLTDTQY'	0.027%	0.017%	0.844%	0.204%	Yes
'CASSLTTRIDEQY'	1.025%	0.457%	0.441%	0.439%	Yes
'CASSLVPGYDQPQH'	0.243%	0.029%	0.028%	N.D.	
'CASSPGLAGYGYT'	N.D.	0.610%	0.093%	N.D.	
'CASSPGQGAHSYEQY'	N.D.	N.D.	1.471%	N.D.	
'CASSPGQGYGYT'	N.D.	0.004%	0.811%	0.172%	
'CASSPNGGYGYT'	N.D.	0.294%	N.D.	N.D.	

'CASSPQGANGYT'	N.D.	0.619%	0.086%	N.D.	
'CASSPQGASGYT'	N.D.	0.350%	0.034%	N.D.	
'CASSPQKAAAYRPDSGANVLT'	N.D.	N.D.	0.942%	0.016%	
'CASSPRGSGSESANVLT'	0.013%	0.001%	N.D.	0.948%	
'CASSPSTGLYNEQF'	N.D.	N.D.	N.D.	0.235%	
'CASSQAGTGFVEQY'	0.432%	0.581%	0.300%	0.517%	Yes
'CASSQAGTGWDTEAF'	0.013%	8.523%	0.038%	0.047%	Yes
'CASSQDGYGANVLT'	0.040%	N.D.	N.D.	0.400%	
'CASSQDRSSTDTQY'	N.D.	N.D.	0.730%	N.D.	
'CASSQEEVPYNEQF'	N.D.	N.D.	9.734%	0.039%	
'CASSQGQVSNTAF'	N.D.	N.D.	1.104%	N.D.	
'CASSQGTSSGDTQY'	N.D.	N.D.	0.716%	0.008%	
'CASSQPGRQAF'	N.D.	N.D.	0.688%	0.008%	
'CASSQYDNEQY'	0.148%	0.145%	0.266%	0.690%	Yes
'CASSSPGSPSYNEQF'	N.D.	0.231%	0.005%	N.D.	
'CASSSRLAGGSETQY'	0.013%	0.025%	0.093%	0.415%	Yes
'CASSSRLAGGTDQY'	0.216%	0.130%	0.216%	3.072%	Yes
'CASSTRLAGGTDQY'	0.020%	0.025%	0.092%	0.964%	Yes
'CASSVAWDGNQPQH'	0.358%	0.207%	0.121%	0.016%	Yes
'CASSWTGPYEQY'	N.D.	0.233%	0.018%	N.D.	
'CASSYNGAYNEQF'	0.189%	0.126%	0.122%	0.094%	Yes
'CASSYSEGVSPNTEAF'	N.D.	0.023%	1.756%	0.274%	
'CASSYSTGQGRSTDTQY'	0.715%	0.011%	0.008%	0.125%	Yes
'CASSYYDPSVNTGELF'	9.019%	0.090%	0.031%	0.016%	Yes
'CASSYYPGRGNEQF'	0.783%	0.306%	0.324%	0.329%	Yes
'CASTATGAADTQY'	0.108%	0.078%	0.073%	0.243%	Yes
'CATKAGTSVNEQF'	N.D.	0.500%	0.026%	N.D.	
'CATSEHPGGFSQY'	0.027%	0.008%	1.146%	0.118%	Yes
'CATSGLAGETQY'	N.D.	N.D.	0.627%	N.D.	
'CSASGTDYNEQF'	N.D.	0.005%	0.548%	0.016%	
'CVAKGPPNEQF'	0.600%	0.168%	0.243%	0.204%	Yes
YYS	First	Second	Third		TCPI_{20=27/27}
'CAISESTRNQPQH'	0.245%	0.375%	0.077%		Yes
'CASGPGGSGANVLT'	0.677%	0.135%	0.618%		Yes
'CASLGTGTSGSYEQY'	1.512%	0.595%	0.206%		Yes
'CASRGRGMDGYT'	0.797%	0.491%	0.472%		Yes
'CASRLAGGPGDTQY'	7.184%	2.710%	8.779%		Yes
'CASRTGGAGEAF'	13.502%	8.437%	18.227%		Yes
'CASRTRGAGEAF'	1.532%	0.863%	2.019%		Yes
'CASSGGSSAAGEQF'	0.495%	0.275%	0.756%		Yes
'CASSGRGSSSYEQY'	0.392%	0.550%	0.112%		Yes
'CASSKTSGSGDEQF'	0.966%	1.150%	1.168%		Yes
'CASSLAGSGANVLT'	1.431%	1.431%	1.752%		Yes

'CASSLLVSGTYEQY'	0.192%	0.485%	0.026%	Yes
'CASSLPGVFGETQY'	3.387%	2.950%	5.463%	Yes
'CASSLTGDLYEQY'	0.535%	0.965%	1.280%	Yes
'CASSLYLPTDTQY'	0.001%	0.035%	1.709%	Yes
'CASSPNRGPPNEKLF'	0.882%	1.050%	1.014%	Yes
'CASSPTGSAYPGSCF'	0.267%	0.267%	0.438%	Yes
'CASSPTGVGIPGELF'	3.709%	3.117%	9.560%	Yes
'CASSQNQGAGGNQPQH'	0.916%	1.142%	2.766%	Yes
'CASSSGTTYEQY'	1.922%	0.406%	0.558%	Yes
'CASSSLGGQETQY'	0.590%	0.246%	0.369%	Yes
'CASSSLTSGRQETQY'	0.669%	0.234%	0.163%	Yes
'CASTNVGTGSNEQF'	0.103%	0.200%	0.412%	Yes
'CASTTSGSQEQY'	0.793%	0.744%	0.120%	Yes
'CATSRGAGRQETQY'	0.514%	1.345%	6.751%	Yes
'CATSSGPSNTEAF'	3.603%	1.210%	2.963%	Yes
'CVSMDGNTGELF'	2.522%	1.558%	3.058%	Yes
ZHF	First	Second	Third	TCPI₂₀=19/50
'CASEPRDRGWNEQF'	0.408%	0.013%	0.003%	Yes
'CASFGNTVLYGYT'	0.498%	N.D.	N.D.	
'CASGQPQH'	0.476%	0.316%	0.049%	Yes
'CASGTGGSGANVLT'	0.048%	0.337%	0.003%	Yes
'CASGTSSEQF'	N.D.	0.283%	N.D.	
'CASNAGVWDEQF'	0.339%	N.D.	N.D.	
'CASSAAGNTEAF'	0.339%	N.D.	N.D.	
'CASSAFFEDEAF'	0.005%	1.210%	0.570%	Yes
'CASSDFIGHGYEQY'	0.312%	N.D.	N.D.	
'CASSDNQETQY'	0.386%	N.D.	N.D.	
'CASSEGREPQH'	N.D.	0.197%	2.074%	
'CASSESTYRSYNEQF'	0.402%	0.002%	0.003%	Yes
'CASSFVRGDRDDTQY'	N.D.	0.373%	2.375%	
'CASSKLSGRGELF'	0.048%	0.528%	7.912%	Yes
'CASSLEGTATKNIQY'	N.D.	0.077%	1.377%	
'CASSLGQNQPQH'	N.D.	0.092%	2.922%	
'CASSLLAGENYNEQF'	N.D.	0.706%	N.D.	
'CASSLSIGCCGYT'	N.D.	0.362%	0.332%	
'CASSLTGYNEQF'	0.053%	0.266%	0.106%	Yes
'CASSPDRGYNEQF'	N.D.	0.427%	0.001%	
'CASSPGENEQF'	0.498%	0.082%	0.009%	Yes
'CASSPGLHNEQF'	N.D.	1.003%	N.D.	
'CASSPGTSGTGSYEQY'	0.005%	0.071%	0.834%	Yes
'CASSPLFLPSSYNEQF'	0.720%	1.051%	0.666%	Yes
'CASSPSRTGGENEQF'	0.423%	0.004%	N.D.	
'CASSQDAGGYTGELF'	0.328%	N.D.	N.D.	

'CASSQGQRFVTEAF'	N.D.	0.176%	2.816%	
'CASSQGRGTGETEAF'	N.D.	0.153%	1.713%	
'CASSQTTGIQRAF'	N.D.	0.013%	1.046%	
'CASSSFTSGSPDTQY'	0.312%	N.D.	N.D.	
'CASSSGQALTEAF'	N.D.	0.147%	0.764%	
'CASSSGTAGQPQH'	0.386%	N.D.	N.D.	
'CASSSLDGDTTYEQY'	N.D.	0.278%	0.896%	
'CASSSQGNTEAF'	N.D.	0.023%	0.699%	
'CASSTGHPNTEAF'	N.D.	0.017%	0.711%	
'CASSTQTGGYGYT'	N.D.	0.054%	2.266%	
'CASSTSGTGLRGYT'	0.529%	N.D.	N.D.	
'CASSVGLLETGELF'	0.042%	1.357%	0.007%	Yes
'CASSVGLYNEQF'	0.487%	2.881%	0.004%	Yes
'CASSYETGGNEQF'	0.148%	0.601%	0.624%	Yes
'CASSYGGLYNEQF'	0.413%	0.008%	0.003%	Yes
'CASSYGQGAGGYT'	0.630%	1.026%	0.335%	Yes
'CASSYLREYEQF'	0.053%	0.574%	0.734%	Yes
'CASSYPQGKLF'	0.386%	0.013%	0.001%	Yes
'CASSYSGAGGLQETQY'	0.318%	0.065%	0.001%	Yes
'CASTTLSYSNQPQH'	N.D.	0.442%	0.738%	
'CASYDGLTTEAF'	N.D.	N.D.	0.749%	
'CATSRLAGEEQF'	0.037%	2.691%	17.683%	Yes
'CAVRGSISTGELF'	N.D.	0.027%	0.965%	
'CSASPQSYEQY'	N.D.	0.036%	0.709%	
