

Transfusion Independence and Elimination of Vaso-Occlusive Crises After Exagamglogene Autotemcel in Transfusion-Dependent β -Thalassemia and Severe Sickle Cell Disease

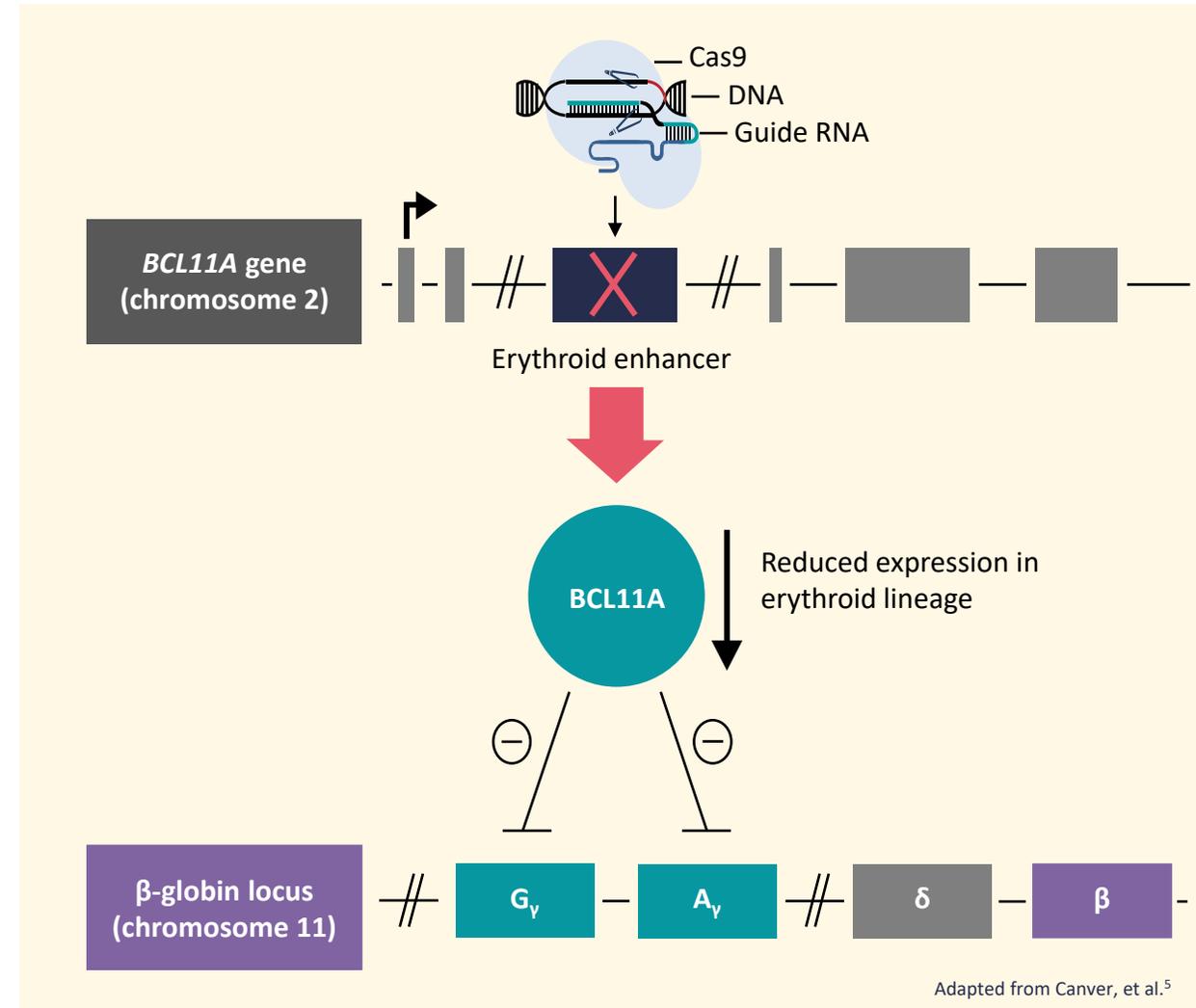
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Exa-cel Is a Cell Product Consisting of Autologous CD34⁺ HSPCs Modified Using Non-viral, *Ex Vivo* CRISPR-Cas9

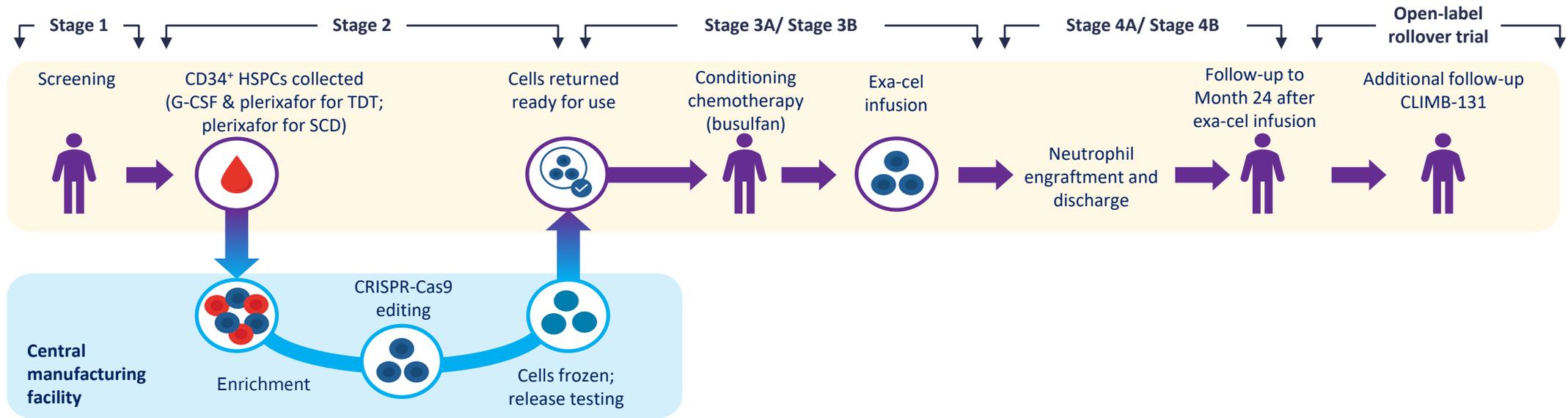
- **Elevated levels of HbF**, such as in hereditary persistence of fetal hemoglobin, are associated with **reduced morbidity and mortality** in patients with **TDT¹ and SCD¹**
- HbF production is developmentally regulated, with **BCL11A suppressing HbF** after the first months of life^{2,3}
- **Exa-cel** is produced using non-viral, *ex vivo* editing of the erythroid-specific enhancer region of **BCL11A** in CD34⁺ HSPCs **to reduce erythroid-specific expression of BCL11A**
- **Infusion of exa-cel increases HbF** to levels similar to hereditary persistence of fetal hemoglobin, eliminating the need for **RBC transfusions** and **eliminating VOCs⁴**



BCL11A, B-cell lymphoma/leukemia 11A; **Cas9**, CRISPR-associated 9 nuclease; **CRISPR**, clustered regularly interspaced short palindromic repeats; **DNA**, deoxyribonucleic acid; **exa-cel**, exagamglogene autotemcel; **HbF**, fetal hemoglobin; **HSPC**, hematopoietic stem and progenitor cell; **RBC**, red blood cells; **RNA**, ribonucleic acid; **SCD**, sickle cell disease; **TDT**, transfusion-dependent β -thalassemia, **VOC**, vaso-occlusive crisis.

1. Steinberg MH, et al. *Blood*. 2020;136(21):2392-2400. 2. Sankaran VG, Orkin SH. *Cold Spring Harb Perspect Med*. 2013;3(1):a011643. 3. Bauer DE, et al. *Curr Opin Gene Dev*. 2015;33:62-70. 4. Frangoul H, et al. *N Engl J Med*. 2021; 384(3):252-260; 5. Canver MC, et al. *Blood*. 2016;127(21):2536-2545.

Pivotal Phase 3 Trials of Exa-cel in Participants With TDT and Severe SCD



	CLIMB THAL-111 in TDT	CLIMB SCD-121 in SCD
Study Design	International, multicenter, open-label, single-arm, 2-year Phase 3 trial of a single infusion of exa-cel (NCT03655678)	International, multicenter, open-label, single-arm, 2-year Phase 3 trial of a single infusion of exa-cel (NCT03745287)
Participants Dosed	48 participants dosed	35 participants dosed
Key Inclusion Criteria	Twelve to 35 years of age with TDT, including β^0/β^0 genotypes, defined as a history of ≥ 100 mL/kg/year or ≥ 10 units/year of pRBC transfusions in the previous 2 years	Twelve to 35 years of age with severe SCD and a history of ≥ 2 severe VOCs per year in the previous 2 years
Pre-specified Analysis	<ul style="list-style-type: none"> Full Analysis Set: participants who received exa-cel infusion Primary Efficacy Set: participants followed for ≥ 16 months after exa-cel infusion (evaluable for primary & key secondary endpoints) Pre-specified interim analysis: conducted when primary efficacy set included 27 participants in CLIMB THAL-111 and 17 participants in CLIMB SCD-121 	

Participants who complete CLIMB THAL-111 or CLIMB SCD-121 can enroll in CLIMB-131 for 13 years of additional follow-up

The data cutoff date for the pre-specified interim analysis was 06Sept2022 for CLIMB THAL-111 and 16Sept2022 for CLIMB SCD-121.

CRISPR-Cas9, clustered regularly interspaced short palindromic repeats-associated 9 nuclease; **exa-cel**, exagamglogene autotemcel; **G-CSF**, granulocyte colony-stimulating factor; **HSPC**, hematopoietic stem and progenitor cell; **pRBC**, packed red blood cell; **SCD**, sickle cell disease; **TDT**, transfusion dependent β -thalassemia; **VOC**, vaso-occlusive crisis.

Pivotal Trial Endpoints

TDT

SCD

Primary Efficacy Endpoint

Proportion of participants **transfusion independent for 12 consecutive months** while maintaining a weighted average hemoglobin ≥ 9 g/dL (**TI12**)

- Assessed starting 60 days after last RBC transfusion for post-transplant support or TDT disease management

Proportion of participants **free of severe VOCs for ≥ 12 consecutive months (VF12)**

- Assessed starting 60 days after last RBC transfusion for post-transplant support or SCD disease management

Key Secondary Efficacy Endpoint

Proportion of participants **transfusion independent for 6 consecutive months** while maintaining a weighted average hemoglobin ≥ 9 g/dL (**TI6**)

- Assessed starting 60 days after last RBC transfusion for post-transplant support or TDT disease management

Proportion of participants **free from in-patient hospitalization for severe VOCs for ≥ 12 consecutive months (HF12)**

- Assessed starting 60 days after last RBC transfusion for post-transplant support or SCD disease management

Secondary & Other Efficacy Endpoints*

- Total hemoglobin concentration
- Fetal hemoglobin concentration
- Proportion of F-cells
- Proportion of alleles with intended genetic modification in peripheral blood
- Proportion of alleles with intended genetic modification in CD34+ cells of the bone marrow
- Change over time in patient reported outcome measures

Safety Endpoints

- Neutrophil and platelet engraftment
- Safety and tolerability assessments, including adverse events, clinical laboratory values, and vital signs

* The clinical protocol for these trials included additional secondary endpoints.

F-cells, circulating RBCs expressing detectable levels of HbF; **LDH**, lactate dehydrogenase; **RBC**, red blood cell; **SCD**, sickle cell disease; **TDT**, transfusion dependent β -thalassemia; **VOC**, vaso-occlusive crisis.

TDT: Demographics and Baseline Clinical Characteristics

	Full Analysis Set N = 48	Primary Efficacy Set N=27
Sex, n (%)		
Male	23 (47.9)	14 (51.9)
Female	25 (52.1)	13 (48.1)
Genotype, n (%)		
β^0/β^0	16 (33.3)	6 (22.2)
β^0/β^0 -like (β^0 /IVS-I-110; IVS-I-110/IVS-I-110)	12 (25.0)	9 (33.3)
Non- β^0/β^0 -like	20 (41.7)	12 (44.4)
Age at baseline, years, mean (range)	21.4 (12, 35)	21.8 (12, 32)
≥12 and <18 years, n (%)	16 (33.3)	5 (18.5)
≥18 and ≤35 years, n (%)	32 (66.7)	22 (81.5)
Historical RBC transfusions per year,^a units, mean (range)	35.3 (11.0, 71.0)	36.7 (20.5, 71.0)
Number of mobilization cycles, median (range)	1.0 (1.0, 4.0)	1.0 (1.0, 2.0)
Drug product cell dose, mean (range)		
CD34 ⁺ cells × 10 ⁶ /kg	8.5 (3.0, 19.7)	7.4 (3.0, 15.6)
Duration of follow-up after exa-cel infusion^b, median (range)		
Months	16.7 (0.0, 43.7)	21.1 (13.8, 43.7)

^aAnnualized over 2 years before signing of the informed consent form or the latest rescreening; ^bDuration of follow-up include both CLIMB THAL-111 and CLIMB-131 trials.

SCD: Demographics and Baseline Clinical Characteristics

	Full Analysis Set N = 35	Primary Efficacy Set N=17
Sex, n (%)		
Male	19 (54.3)	9 (52.9)
Female	16 (45.7)	8 (47.1)
Genotype, n (%)		
β^S/β^S	33 (94.3)	17 (100.0)
β^S/β^0	2 (5.7)	0
Age at baseline, years, mean (range)	22.1 (12, 34)	23.5 (18, 34)
≥12 and <18 years, n (%)	8 (22.9)	0
≥18 and ≤35 years, n (%)	27 (77.1)	17 (100.0)
Historical VOC episodes per year,^a mean (range)	4.2 (2.0, 18.5)	4.6 (2.0, 9.5)
Historical in-patient hospitalizations for severe VOCs per year,^a mean (range)	2.6 (0.5, 8.5)	3.2 (0.5, 8.5)
Number of mobilization cycles, median (range)	2.0 (1.0, 6.0)	2.0 (1.0, 5.0)
Drug product cell dose, mean (range)		
CD34 ⁺ cells × 10 ⁶ /kg	4.7 (2.9, 14.4)	3.7 (2.9, 5.3)
Duration of follow-up after exa-cel infusion^b, median (range)		
Months	11.6 (2.0, 39.1)	19.3 (16.0, 39.1)

^aAnnualized over 2 years before signing of the informed consent form; ^bDuration of follow-up include both CLIMB SCD-121 and CLIMB-131 trials.

TDT: Pivotal Trial Met Primary & Key Secondary Endpoints

Primary Efficacy Set
N = 27

Primary Endpoint

Participants who were **transfusion independent for 12 consecutive months** while maintaining a weighted average hemoglobin ≥ 9 g/dL (TI12)^a

n/N	24/27
%	88.9%
2-sided 95% CI	70.8%, 97.6%
1-sided <i>P</i> value ^b	<0.0001 ^c

Key Secondary Endpoint

Participants who were **transfusion independent for 6 consecutive months** while maintaining a weighted average hemoglobin ≥ 9 g/dL (TI6)^a

n/N	24/27
%	88.9%
2-sided 95% CI	70.8%, 97.6%
1-sided <i>P</i> value ^b	<0.0001 ^c

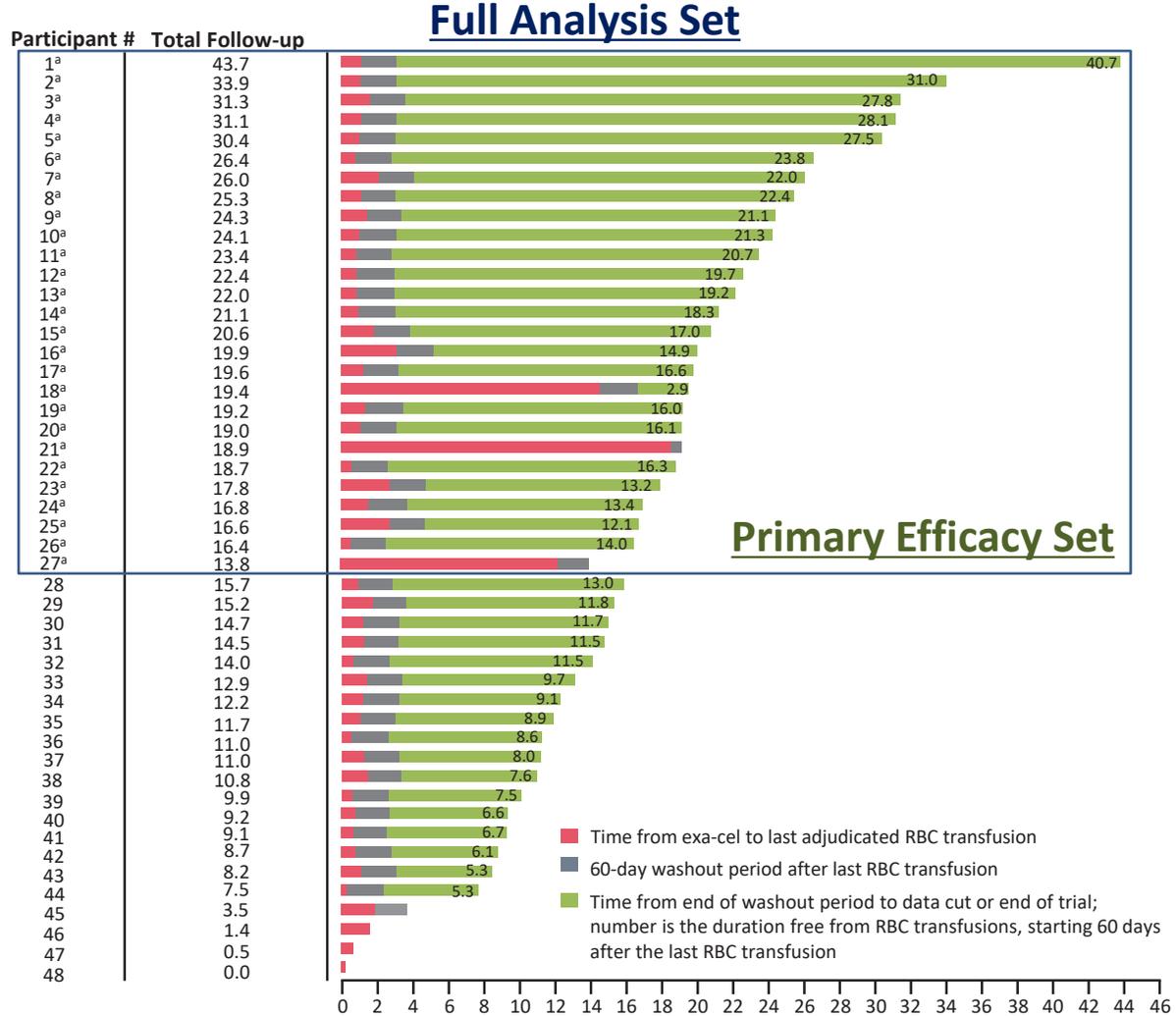
^aAssessed starting 60 days after the last RBC transfusion for post-transplant support or TDT disease management; ^b1-sided *P* value was assessed against a 50% response rate; ^cthis endpoint is considered as statistically significant in the reference of 1-sided alpha = 0.01416.

SCD: Pivotal Trial Met Primary & Key Secondary Endpoints

	Primary Efficacy Set N = 17
Primary Endpoint	
Participants with no severe VOCs for ≥ 12 consecutive months (VF12) ^a	
n/N	16/17
%	94.1%
2-sided 95% CI	71.3%, 99.9%
1-sided <i>P</i> value ^b	0.0001 ^c
Key Secondary Endpoint	
Participants free from in-patient hospitalizations for severe VOCs for ≥ 12 consecutive months (HF12) ^a	
n/N	17/17
%	100.0%
2-sided 95% CI	80.5%, 100.0%
1-sided <i>P</i> value ^b	<0.0001 ^c

^aAssessed starting 60 days after the last RBC transfusion for post-transplant support or SCD disease management; ^b1-sided *P* value was assessed against a 50% response rate; ^cThis endpoint is considered as statistically significant in the reference of 1-sided alpha = 0.0144.

TDT: Participants Who Achieved Transfusion Independence (TI12) Had Normal Hemoglobin and Maintained Transfusion Independence From 12.1 to 40.7 Months



Each row in the figure represents an individual participant.
^aParticipants evaluable for the primary endpoint.

Participants Who Achieved TI12 had Durable Transfusion Independence with Normal Mean Hemoglobin

- Duration of **transfusion independence** of 12.1 to 40.7 months (mean of 20.5 months)
 - Participants **stopped transfusions** after a mean of 37 days
 - Once T12 achieved, all participants **remained transfusion independent through follow-up**

- **Maintained normal mean hemoglobin** of 12.9 g/dL (SD 1.6)

Participants Who did Not Achieve TI12 had Substantial Benefit

- **Three participants** did not achieve TI12
 - 1 participant **stopped transfusions** 14.5 months after exa-cel infusion and was **transfusion free** for 2.9 months
 - 2 participants had **significant reductions in transfusion volume** (80% and 96%)

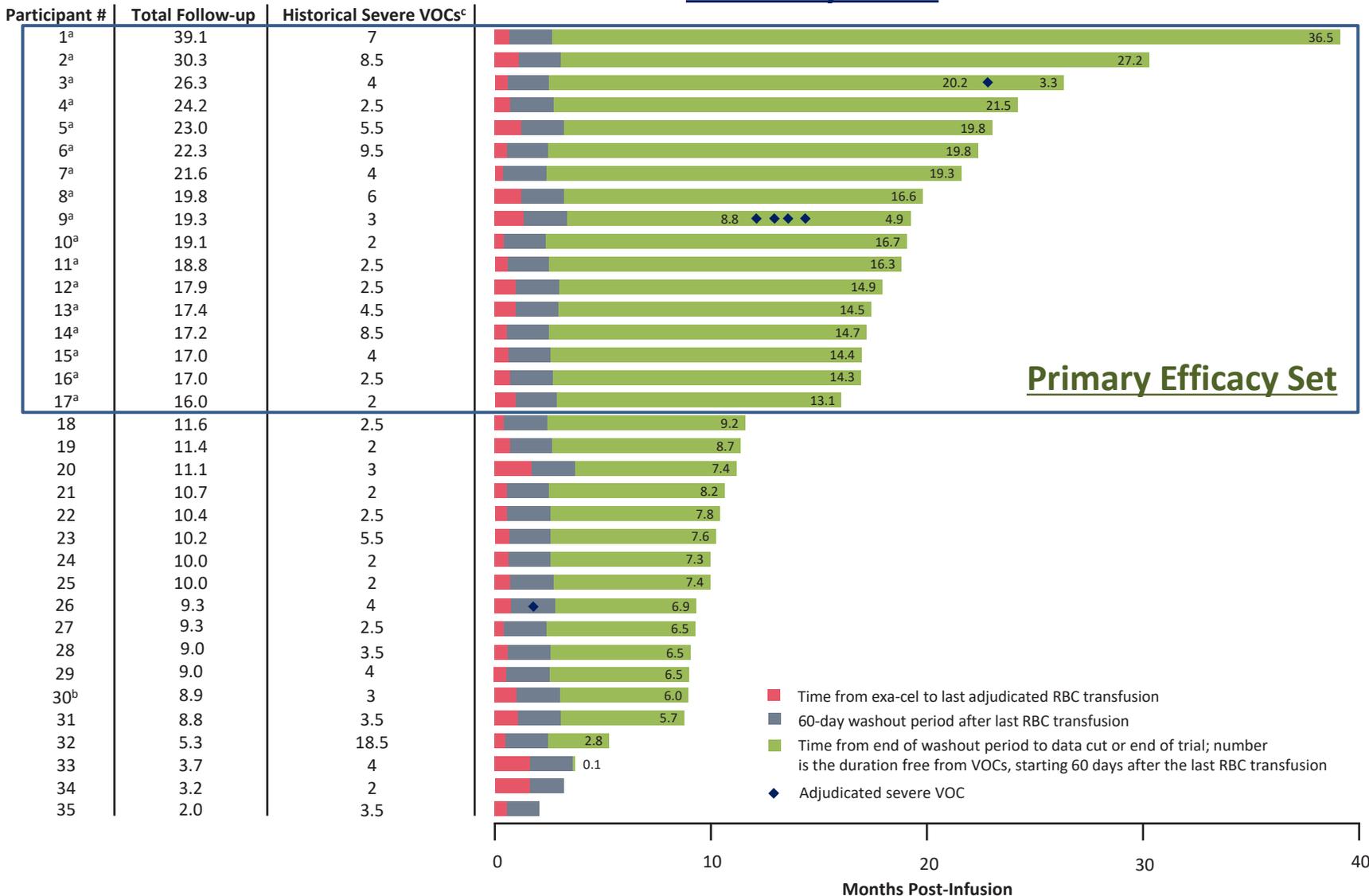
Majority of Trial Participants Stopped RBC Transfusions

- **Excluding participants with <3.5 months of follow-up (N=4), 42 of 44 (95.5%)** participants stopped RBC transfusions (duration 2.9 to 40.7 months)
- **Efficacy was consistent** across genotype, age, and sex subgroup

exa-cel, exagamglogene autotemcel; RBC, red blood cell; SD, standard deviation; TDT, transfusion dependent β-thalassemia; TI6, maintained weighted average Hb ≥9 g/dL without RBC transfusions for at least 6 consecutive months any time after exa-cel infusion; TI12, maintained weighted average Hb ≥9 g/dL without RBC transfusions for at least 12 consecutive months any time after exa-cel infusion.

SCD: Participants Who Achieved Freedom from VOC (VF12) Maintained VOC-Free From 13.1 Months to 36.5 Months

Full Analysis Set

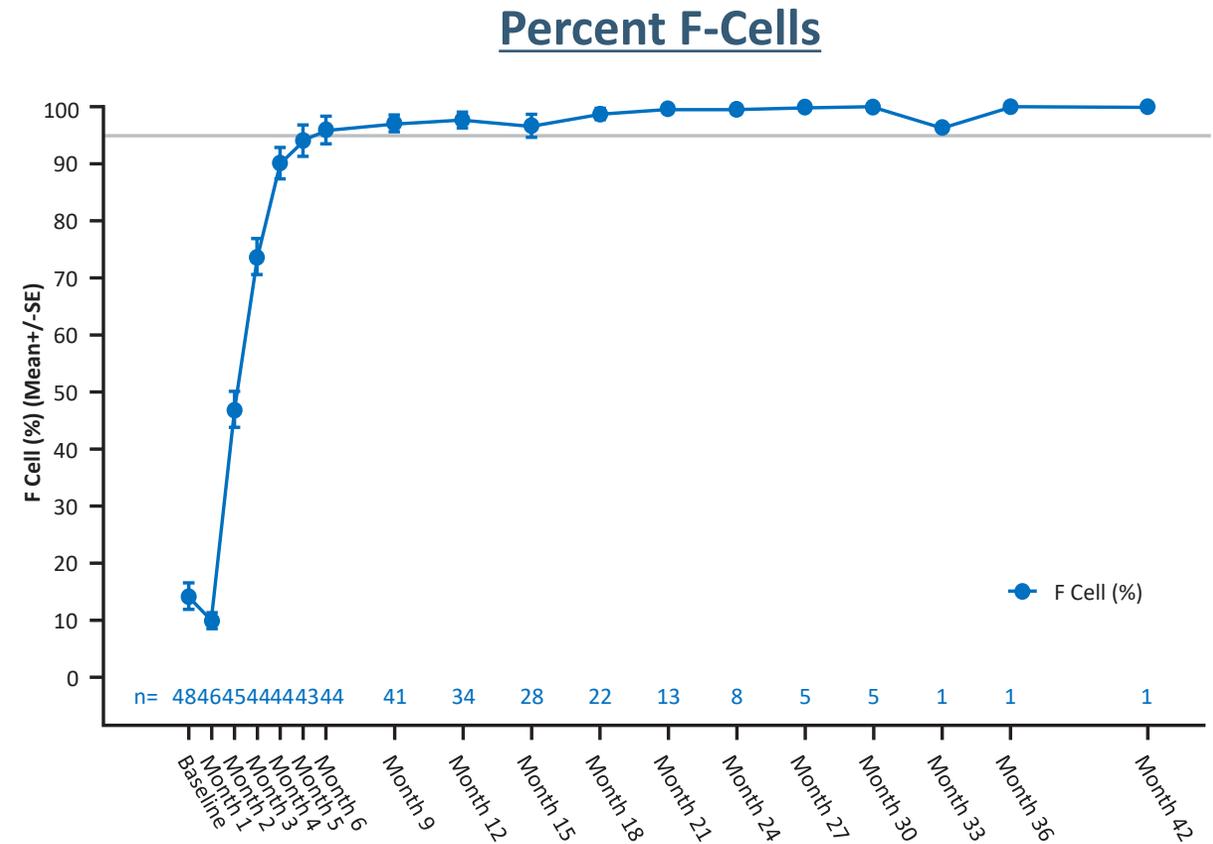
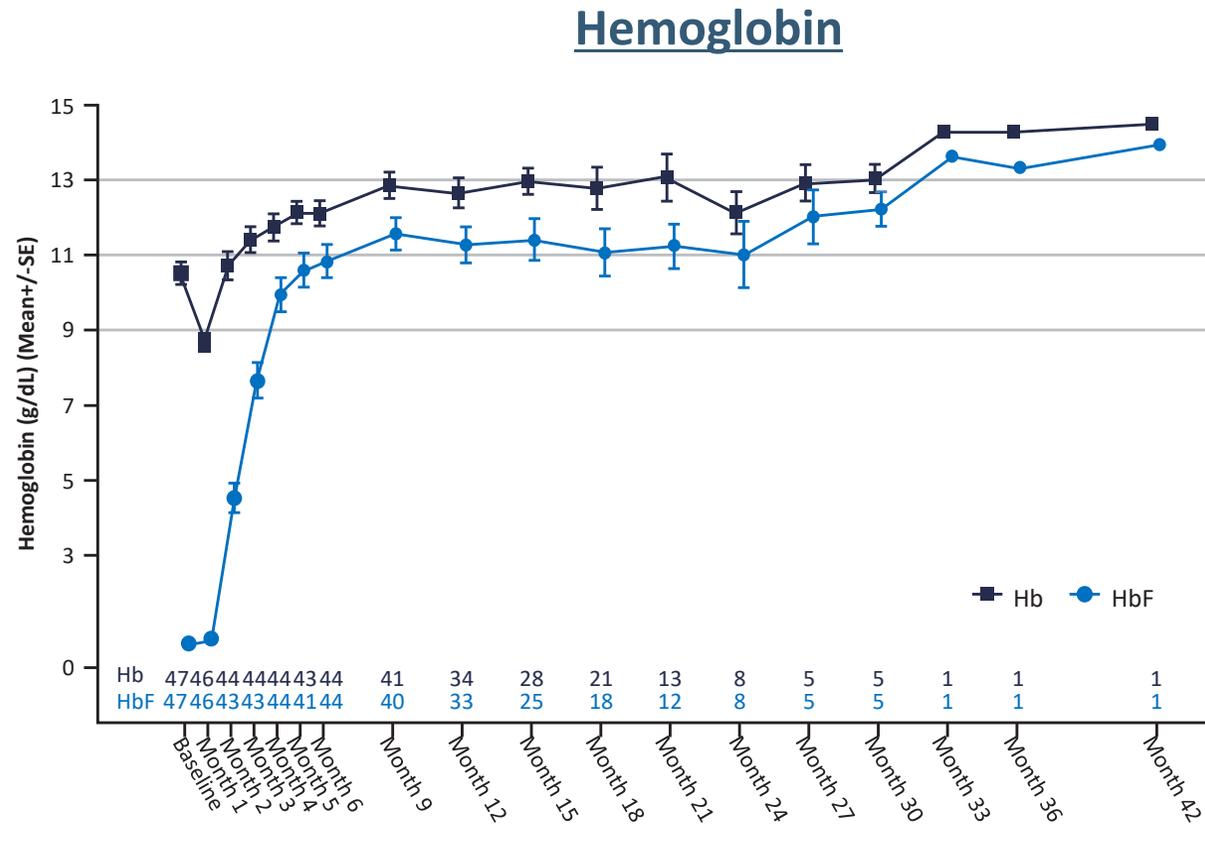


- For participants achieving VF12, duration of VOC-free was 13.1 to 36.5 months (mean 18.7 months)
 - Participants **stopped transfusions** after a mean of 22.5 days
- One participant did not achieve VF12 but achieved HF12
 - Participant had multiple **complex comorbidities**, including a history of chronic pain
- 15 of 16 participants remained **VOC-free** through follow-up
 - One participant had a **VOC** in the setting of a parvovirus **infection** 22.8 months after exa-cel infusion
 - Participant **fully recovered** and has been **VOC-free since**

Each row in the figure represents an individual participants. All VOCs were adjudicated by the Independent Adjudication Committee.

^aParticipants evaluable for the primary endpoint; ^bDeath from respiratory failure due to COVID-19 infection; ^cPre-trial severe VOCs annualized over 2 years.

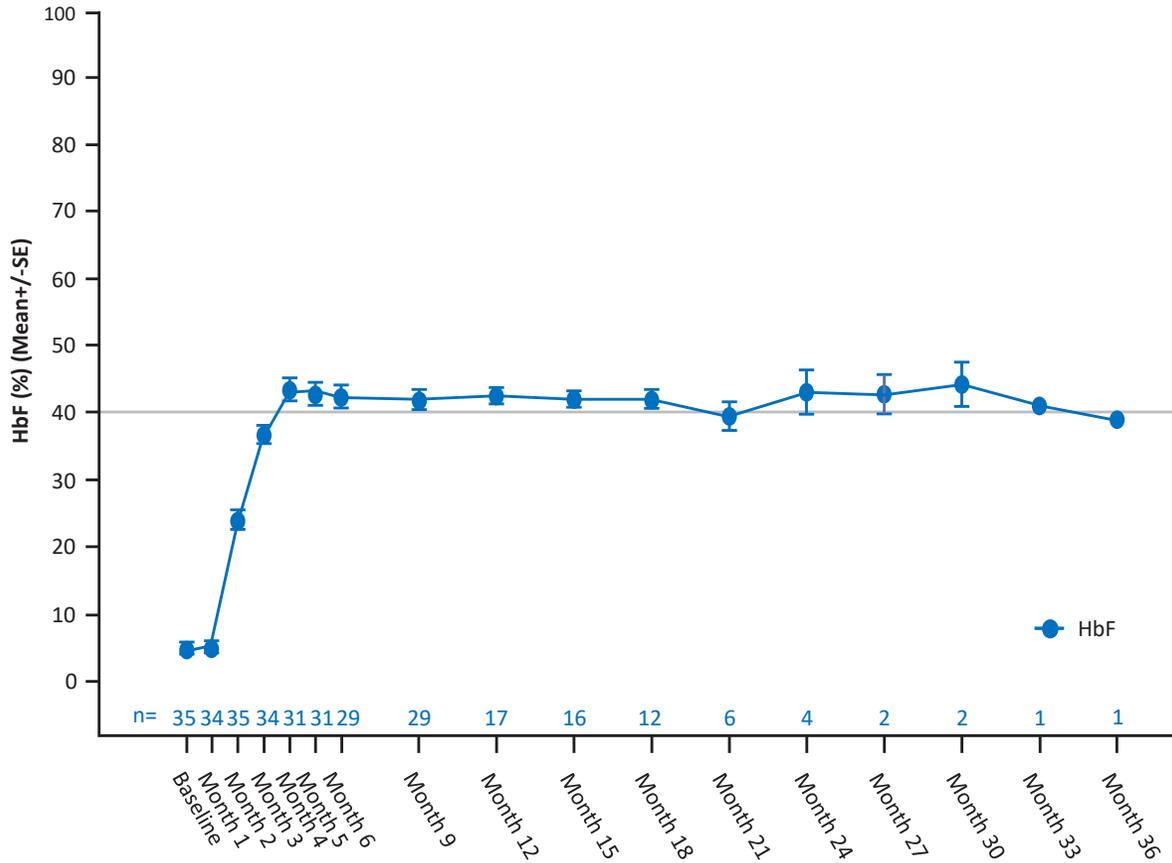
TDT: Early and Sustained Increases in Total Hemoglobin and Fetal Hemoglobin with Pancellular Distribution Following Exa-Cel Infusion



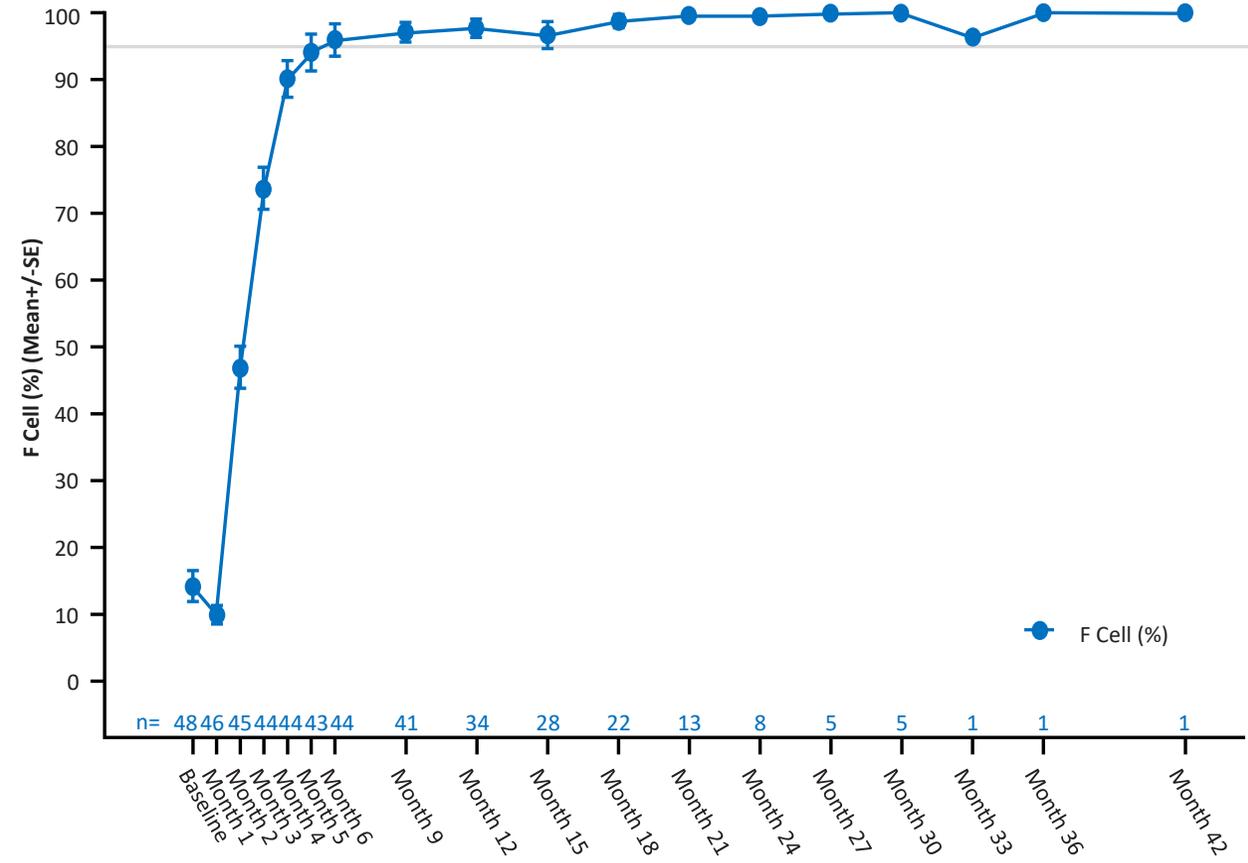
- Mean HbF ≥ 6 g/dL at Month 3; ≥ 9 g/dL at Month 6 and onward
- Mean total Hb ≥ 11 g/dL at Month 3; ≥ 12 g/dL at Month 6 and onward
- Pancellular distribution of HbF observed early and maintained following exa-cel infusion: $>95\%$ of red blood cells express fetal hemoglobin

SCD: Early and Sustained Increases in Total Hemoglobin and Fetal Hemoglobin with Pancellular Following Exa-Cel Infusion

Percent Fetal Hemoglobin



Percent F-Cells



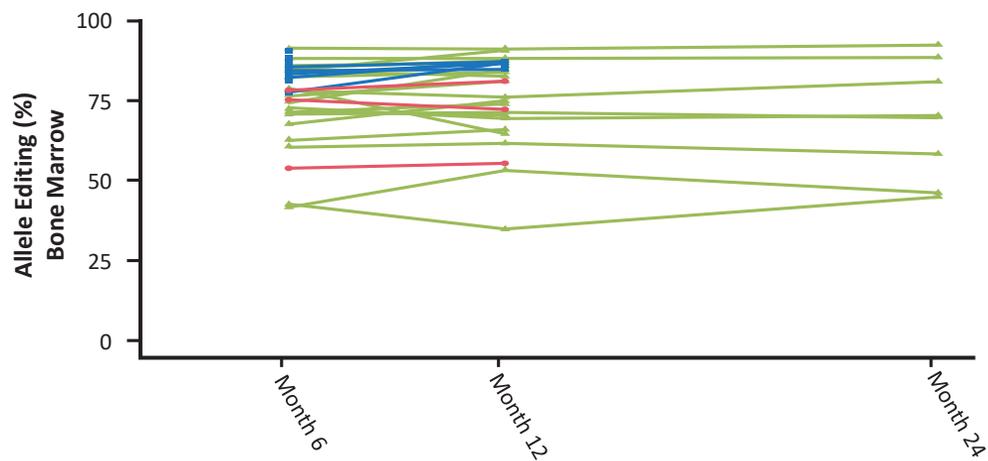
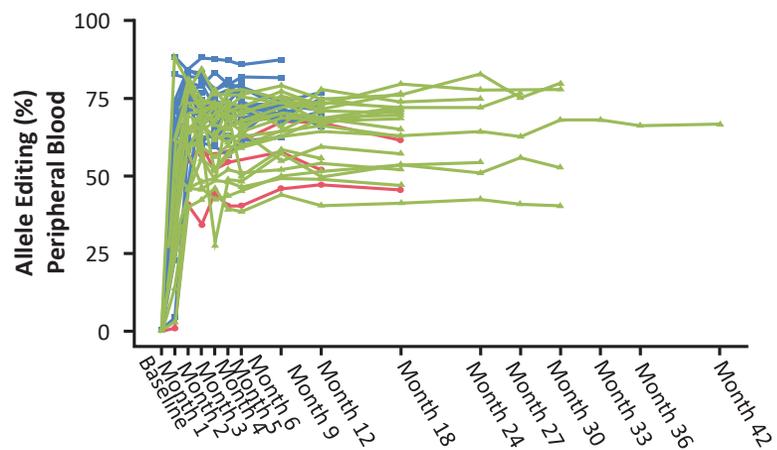
- Mean HbF was 36.8% at Month 3 and was then maintained at ~40.0% through follow-up
- Mean total Hb was 12.0 g/dL at Month 3 and was then maintained at ≥11.0 g/dL through follow-up
- Pancellular distribution of HbF observed early and maintained following exa-cel infusion: >95% of red blood cells express fetal hemoglobin

HbF is measured by high performance liquid chromatography.

exa-cel, exagamlogene autotemcel; **F-cells**, circulating RBCs expressing detectable levels of HbF; **Hb**, hemoglobin; **HbF**, fetal hemoglobin; **RBC**, red blood cell; **SCD**: sickle cell disease; **SE**, standard error.

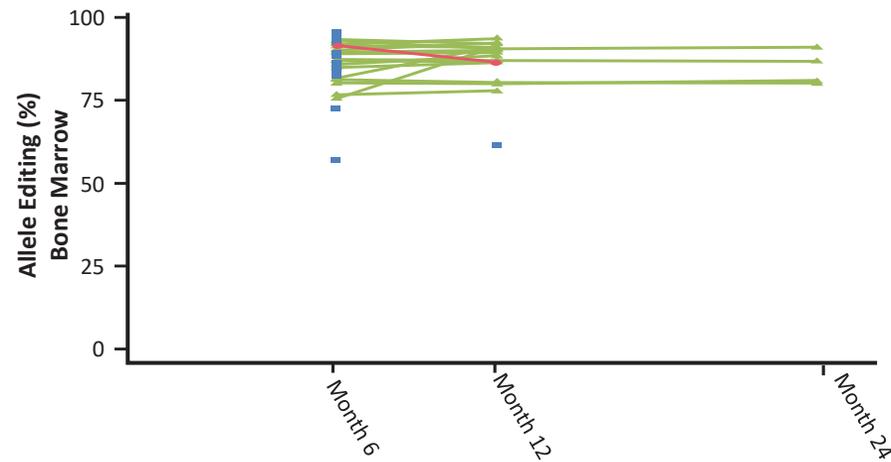
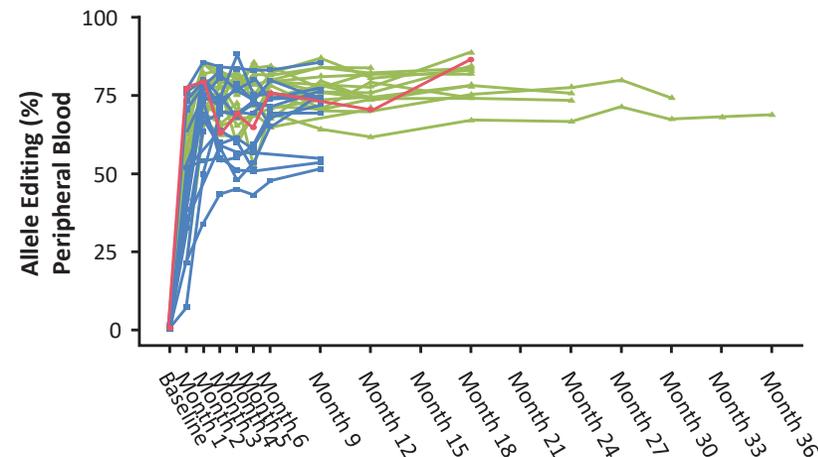
Durable *BCL11A* Editing in Peripheral Blood (Nucleated Cells) and Bone Marrow (CD34⁺ Cells) in both TDT and SCD

TDT



■ Participant NOT in Primary Efficacy Set
 ● T112 Not Achieved
 ▲ T112 Achieved

SCD



■ Participant NOT in Primary Efficacy Set
 ● VF12 Not Achieved
 ▲ VF12 Achieved

Bone marrow allele editing figures include patients who have at least 12 months of follow-up whereas the blood allele editing figures include all patients. *BCL11A*, B-cell lymphoma/leukemia 11A; **SCD**, sickle cell disease; **TDT**, transfusion dependent β -thalassaemia

Patient-Reported Outcome Measures Showed Clinically Meaningful Improvements in Both TDT and SCD

TDT

Visit	EQ VAS (Range: 0-100)	FACT-G Total Score (Range: 0-108)	BMT Score (Range: 0-40)
Baseline mean (SD), points	80.1 (18.7) N=22	83.3 (16.0) N=22	27.3 (5.0) N=22
Change at Month 6, mean (SD), points	+5.2 (18.2) N=22	+2.8 (16.6) N=22	+1.4 (6.3) N=22
Change at Month 12, mean (SD), points	+8.6 (18.6) N=22	+4.2 (20.0) N=22	+3.6 (6.5) N=22
Change at Month 18, mean (SD), points	+8.0 (22.5) N=19	+8.0 (16.6) N=17	+4.4 (5.9) N=17
Change at Month 24, mean (SD), points	+21.0 (20.0) N=8	+17.0 (20.0) N=8	+7.8 (6.0) N=8
MCID	7 to 10 points	3 to 7 points	2 to 3 points

SCD

Visit	EQ VAS (Range: 0-100)	FACT-G Total Score (Range: 0-108)	BMT Score (Range: 0-40)
Baseline mean (SD), points	63.5 (22.5) N=17	67.5 (18.3) N=17	26.1 (3.5) N=17
Change at Month 6, mean (SD), points	+24.3 (27.1) N=16	+16.5 (17.4) N=16	+3.6 (6.2) N=16
Change at Month 12, mean (SD), points	+25.3 (23.2) N=17	+20.5 (18.0) N=17	+5.3 (4.5) N=17
Change at Month 18, mean (SD), points	+33.1 (17.2) N=11	+27.2 (20.3) N=11	+6.7 (4.2) N=11
MCID	7 to 10 points	3 to 7 points	2 to 3 points

Table includes participants in the Primary Efficacy Set.

BMT, bone marrow transplantation subscale; **EQ VAS**, EuroQol visual analog scale; **FACT-G**, Functional Assessment of Cancer Therapy-General; **MCID**, minimum clinically important difference; **SD**, standard deviation.

All Participants Engrafted Neutrophils and Platelets After Exa-cel Infusion

	TDT	SCD
	Exa-cel N = 48	Exa-cel N = 35
Neutrophil Engraftment^a		
Time to neutrophil engraftment (days), median (min, max)	29.0 ^b (12, 56)	27.0 (15, 40)
Platelet Engraftment^c		
Time to platelet engraftment (days), median (min, max)	44.0 ^d (20, 200)	33.0 (23, 81)

^a Defined as the first day of 3 consecutive measurements of absolute neutrophil count ≥ 500 cells/ μ L on 3 different days.

^b Summary statistics included 2 participants who achieved neutrophil engraftment after the data cut date.

^c Defined as the first day of 3 consecutive measurements of unsupported (no platelet transfusion in last 7 days) platelet count $\geq 20,000/\mu$ L for TDT or $\geq 50,000/\mu$ L for SCD on 3 different days.

^d Summary statistics included 3 participants who achieved platelet engraftment after the data cut date.

TDT: Exa-cel Safety Profile Is Consistent With Myeloablative Busulfan Conditioning and Autologous HSCT

Post-Exa-cel AE Overview	Exa-cel N = 48
Participants with	
Any AEs, n (%)	48 (100.0)
AEs related to exa-cel, n (%) ^a	13 (27.1)
AEs related to busulfan, n (%) ^a	45 (93.8)
AEs Grade 3/4, n (%)	41 (85.4)
SAEs, n (%)	17 (35.4)
SAEs related to exa-cel, n (%) ^{a,b}	2 (4.2)
AEs leading to death, n (%)	0
Any malignancies, n (%)	0

All participants engrafted neutrophils and platelets.

^a Includes related and possibly related AEs and SAEs.

^b SAEs previously reported in 2 participants and fully resolved. One participant had SAEs starting peri-engraftment and in the context of HLH (HLH, acute respiratory distress syndrome, and headache were related to exa-cel; idiopathic pneumonia syndrome was related to exa-cel and busulfan). One participant had SAEs of delayed neutrophil engraftment and thrombocytopenia both related to exa-cel and busulfan (neutrophil engraftment achieved on Day 56 without use of backup cells).

Common Adverse Events: Preferred Term	Exa-cel N = 48
Febrile neutropenia	28 (58.3)
Headache	26 (54.2)
Stomatitis	24 (50.0)
Thrombocytopenia	23 (47.9)
Nausea	21 (43.8)
Anaemia	21 (43.8)
Mucosal inflammation	20 (41.7)

Table includes common adverse events occurring in ≥40% of participants.

SCD: Exa-cel Safety Profile Is Consistent With Myeloablative Busulfan Conditioning and Autologous HSCT

Post-Exa-cel AE Overview	Exa-cel N = 35
Participants with	
Any AEs, n (%)	35 (100.0)
AEs related to exa-cel, n (%) ^a	12 (34.3)
AEs related to busulfan, n (%) ^a	35 (100.0)
AEs Grade 3/4, n (%)	34 (97.1)
SAEs, n (%)	14 (40.0)
SAEs related to exa-cel, n (%)	0
AEs leading to death, n (%) ^b	1 (2.9)
Any malignancies, n (%)	0

All patients engrafted neutrophils and platelets.

^a Includes related and possibly related AEs.

^b One death, from respiratory failure due to COVID-19, was not considered to be related to exa-cel.

Common Adverse Events: Preferred Term	Exa-cel N = 35
Nausea	26 (74.3)
Stomatitis	24 (68.6)
Vomiting	21 (60.0)
Abdominal pain	20 (57.1)
Constipation	19 (54.3)
Decreased appetite	19 (54.3)
Platelet count decreased	19 (54.3)
Febrile neutropenia	18 (51.4)
Headache	18 (51.4)
Pain in extremity	18 (51.4)

Table includes common adverse events occurring in ≥50% of participants.

Conclusions on Exa-cel CLIMB THAL-111 and CLIMB SCD-121 Pivotal Trials

- In these pre-specified interim analyses, both pivotal trials met the primary and key secondary endpoints with **transfusion independence** observed for up to **40.7 months in TDT** and with **VOC-free and no in-patient hospitalizations for VOCs for up to 36.5 months in SCD**
 - **TDT:** 24 of 27 participants (88.9%) met the primary (TI12) and key secondary (TI6) endpoints ($P < 0.0001$ against a 50% response rate) with normal mean hemoglobin and a mean transfusion-free duration of 20.5 months; 3 participants who did not meet the primary and key secondary endpoints have either stopped RBC transfusions (for 2.9 months) or significantly reduced transfusion volume (80% and 96% reductions)
 - **SCD:** 16 of 17 participants (94.1%) met the primary endpoint (VF12) of being VOC-free for at least 12 months ($P = 0.0001$ against a 50% response rate) with a mean VOC-free duration of 18.7 months; 17 of 17 participants (100%) met the key secondary endpoint (HF12) of no in-patient hospitalizations for severe VOCs for at least 12 months ($P < 0.0001$ against a 50% response rate)
- Participants had **early and sustained increases in total hemoglobin and fetal hemoglobin with pancellular distribution**
- Stable proportions of *BCL11A* edited alleles were seen in bone marrow and peripheral blood, indicating **successful and durable editing of long-term HSCs** in TDT and SCD
- Participants had **clinically meaningful improvements in quality-of-life** measures
- **Safety profile of exa-cel is consistent** with busulfan myeloablative conditioning and autologous hematopoietic stem cell transplantation, based on 48 participants with TDT and 35 participants with SCD who were dosed with exa-cel

Exa-cel can provide a one-time functional cure to patients with TDT and SCD

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