



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Highlights from IMS 20th Meeting 2023

CAR-T anti-BCMA dopo almeno 1-4 precedenti terapie

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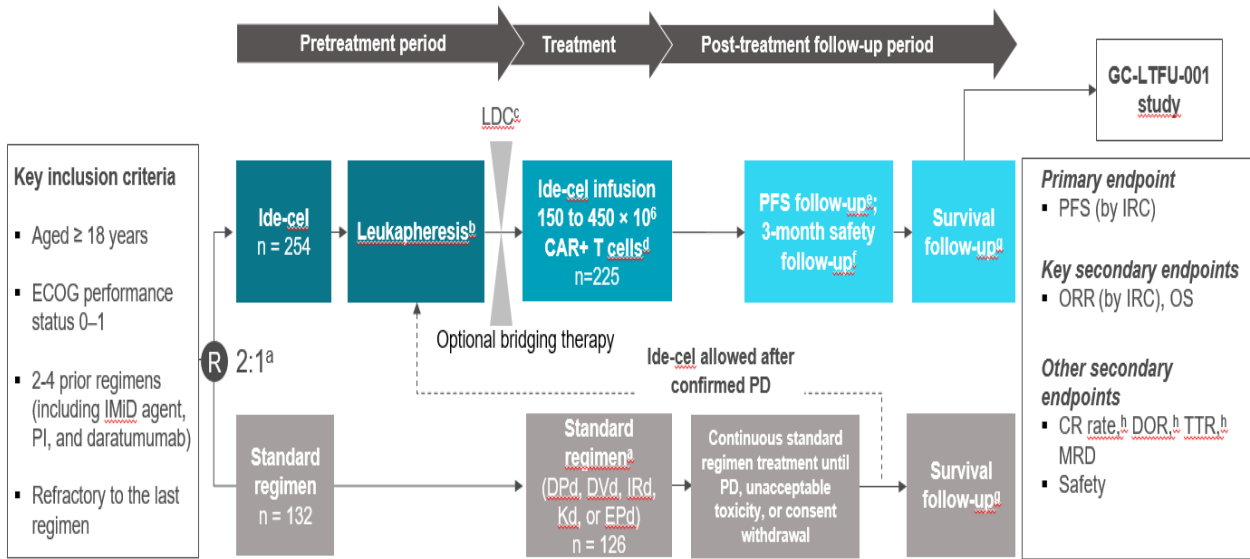
Alma Mater Studiorum – Università degli studi di Bologna

BOLOGNA, 30-31 gennaio 2024 Royal Hotel Carlton

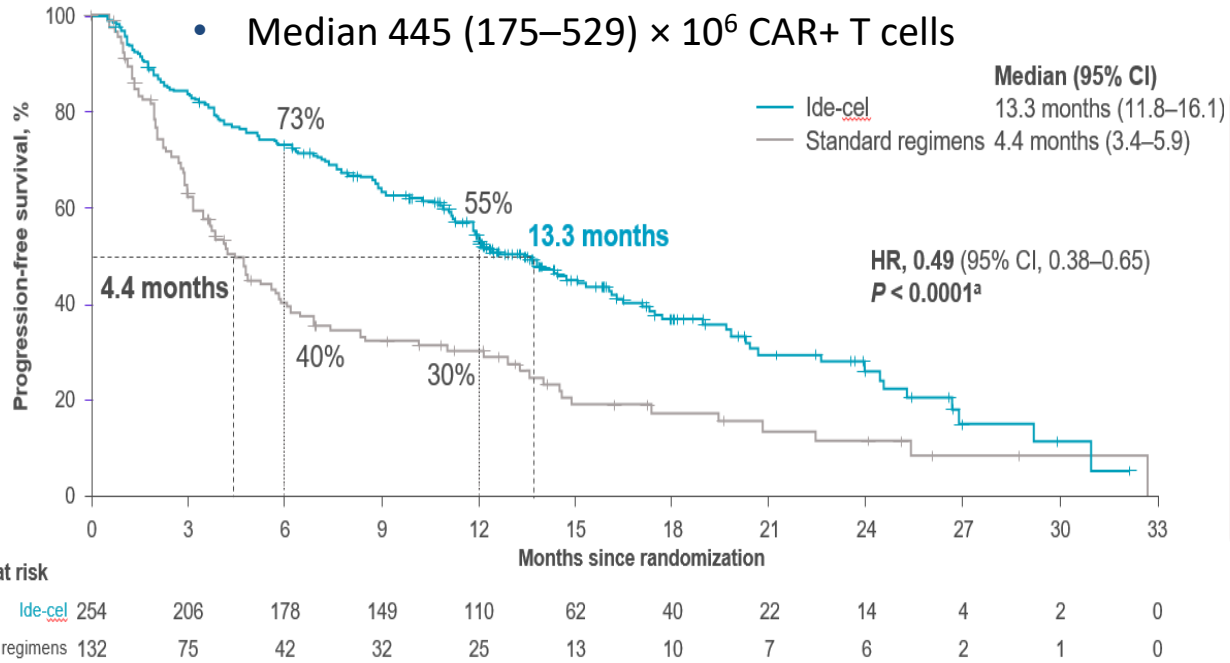
Disclosures: Michele Cavo

Company name	Research support	Employee	Consultant	Stockholder	Speakers bureau	Advisory board	Other
GlaxoSmithKline			x			x	Honoraria
Janssen			x		x	x	Honoraria
Sanofi			x		x	x	Honoraria
Roche			x			x	Honoraria
Amgen			x			x	Honoraria
Takeda			x			x	Honoraria
AbbVie			x			x	Honoraria
Bristol Myers Squibb			x		x	x	Honoraria
Celgene			x		x	x	Honoraria

KarMMa-3: design, baseline characteristics and PFS



Characteristic	Ide-cel (n = 254)	Standard regimens (n = 132)
Median (range) age, years	63 (30–81)	63 (42–83)
Sex, male, n (%)	156 (61)	79 (60)
Median (range) time from diagnosis to screening, years	4.1 (0.2–21.8)	4.0 (0.7–17.7)
High tumor burden, n (%) ^a	71 (28)	34 (26)
Extramedullary disease, n (%) ^b	61 (24)	32 (24)
Treatment	Ide-cel (n = 254)	Standard regimens (n = 132)
Median (range) number of prior regimens	3 (2–4)	3 (2–4)
Median (range) time to progression on last prior antimyeloma therapy, months	7.1 (0.7–67.7)	6.9 (0.4–66.0)
Refractory status, n (%)		
IMiD agent refractory	224 (88)	124 (94)
PI refractory	189 (74)	95 (72)
Daratumumab^a	242 (95)	123 (93)
Double-class refractory ^b	169 (67)	91 (69)
Triple-class refractory^c	164 (65)	89 (67)



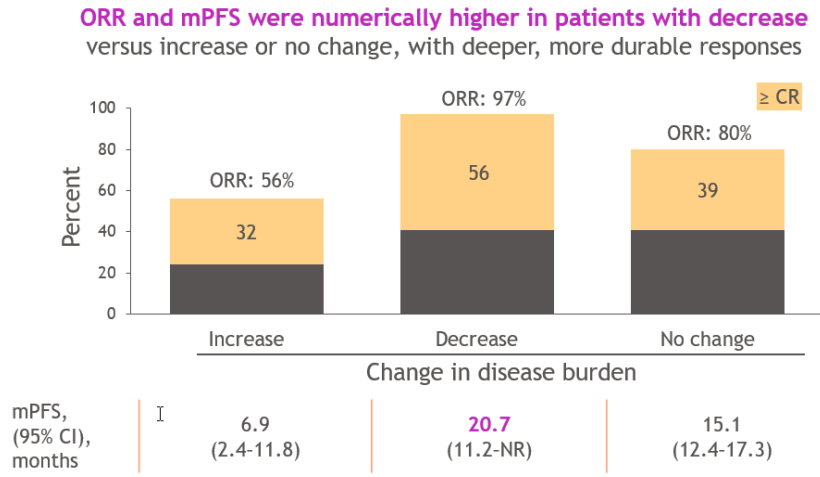
Of 213 patients who received bridging therapy, 200 were evaluable for change in disease burden before ide-cel

- DPd: 45 patients
- DVd: 20
- IRd: 25
- Kd: 26
- EPd: 59
- Other: 25

No. of cycles, median: **1 for all bridging therapy regimens**

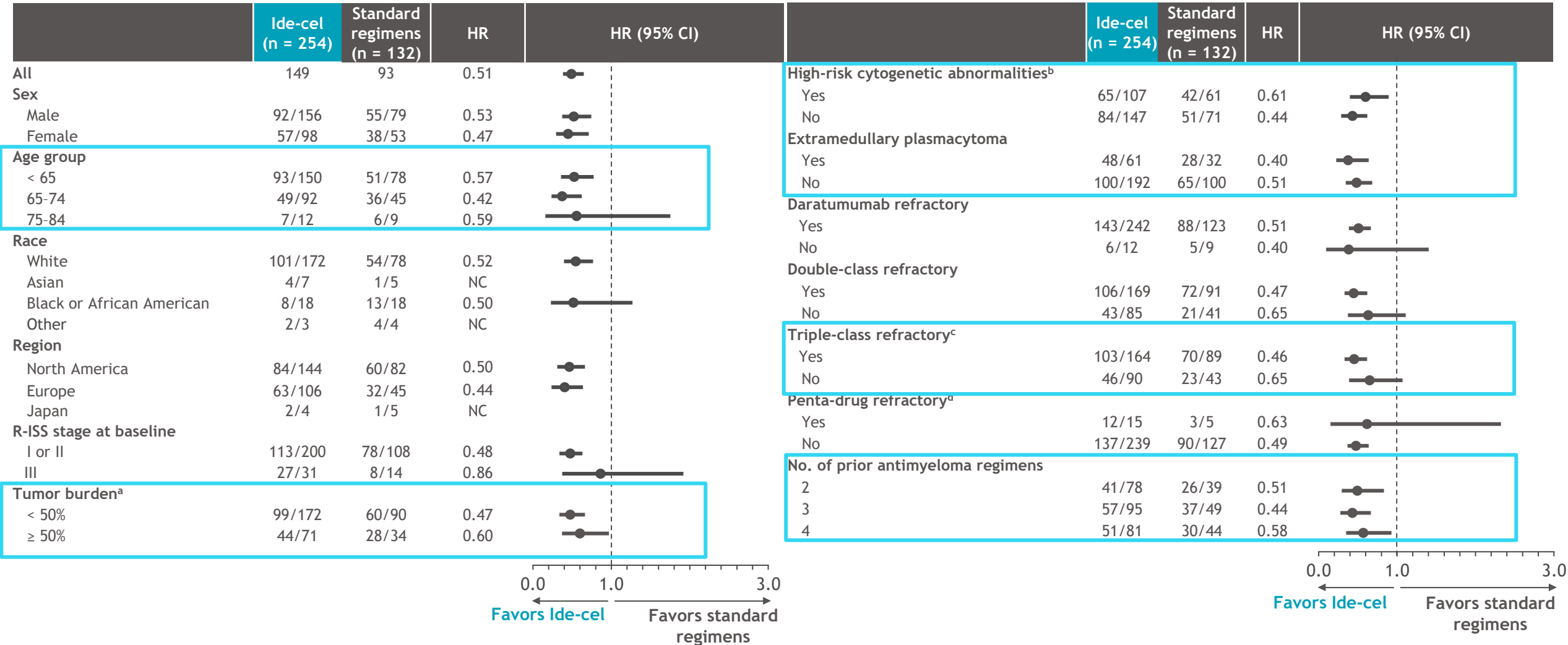
Change in disease burden, %		
Increase	Decrease	No change
28	15	51

A higher proportion of patients with disease burden increase, had EMD, high-risk cytogenetics and TCR disease at baseline versus those with disease burden decrease or no change



Rodriguez-Otero P. et al, N Engl J Med 2023; 388:1002-1014; Einsele H, et al. IMS 2023 encore Poster P008.

PFS: subgroup analysis (ITT population)

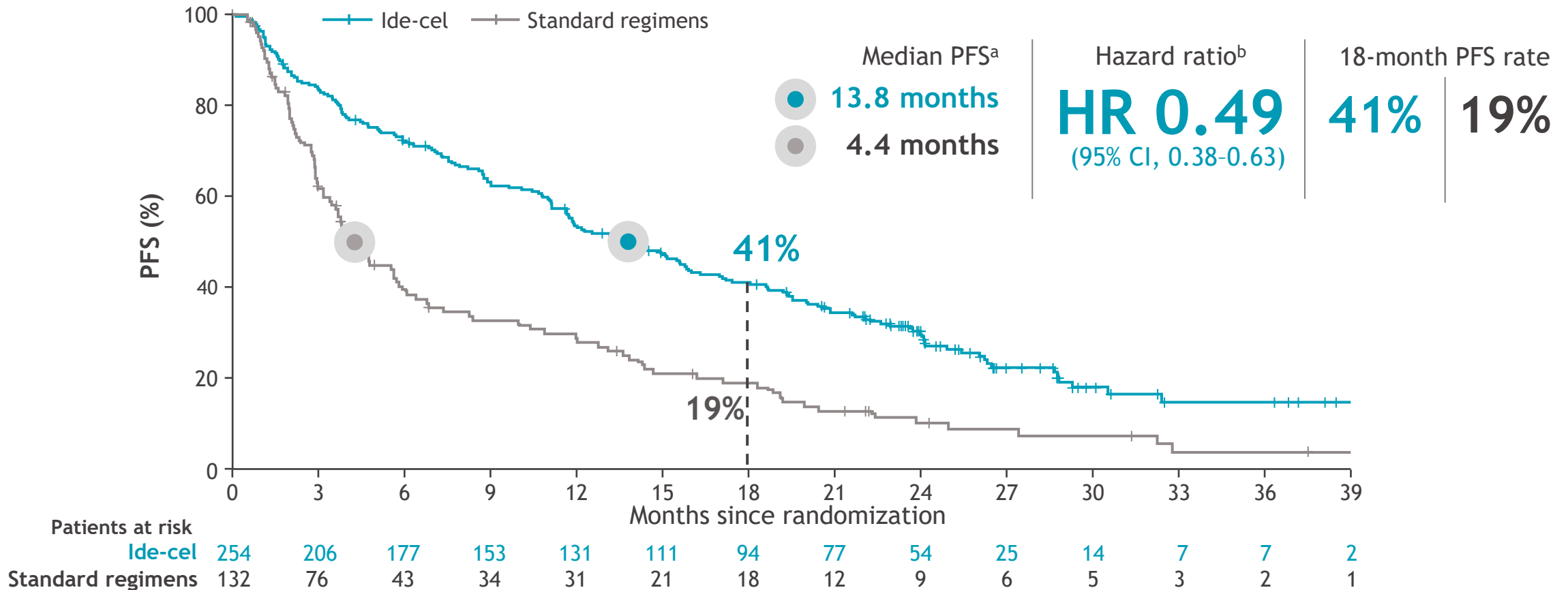


The PFS benefit of ide-cel was consistently observed across multiple patient subgroups

Adapted from Rodríguez-Otero P, et al. Ide-cel or standard regimens in relapsed and refractory multiple myeloma. *N Engl J Med* 2023;388:1002-14.

Per IRC based on IMWG criteria. Assumption of proportional hazards was assessed using a treatment*log(time) interaction term in each model. ^aDetermined by the higher value between bone marrow aspirate and bone marrow biopsy CD138+ plasma cell. Low: < 50%, High: ≥ 50%; ^bDefined as t(4;14), t(14;16), or del(17p); ^cRefractory to ≥ 1 each of an IMiD, a PI, and an anti-CD38 antibody; ^dRefractory to lenalidomide, pomalidomide, bortezomib, carfilzomib, and daratumumab. NC, not computed.

Final PFS analysis at 30.9 months median follow-up

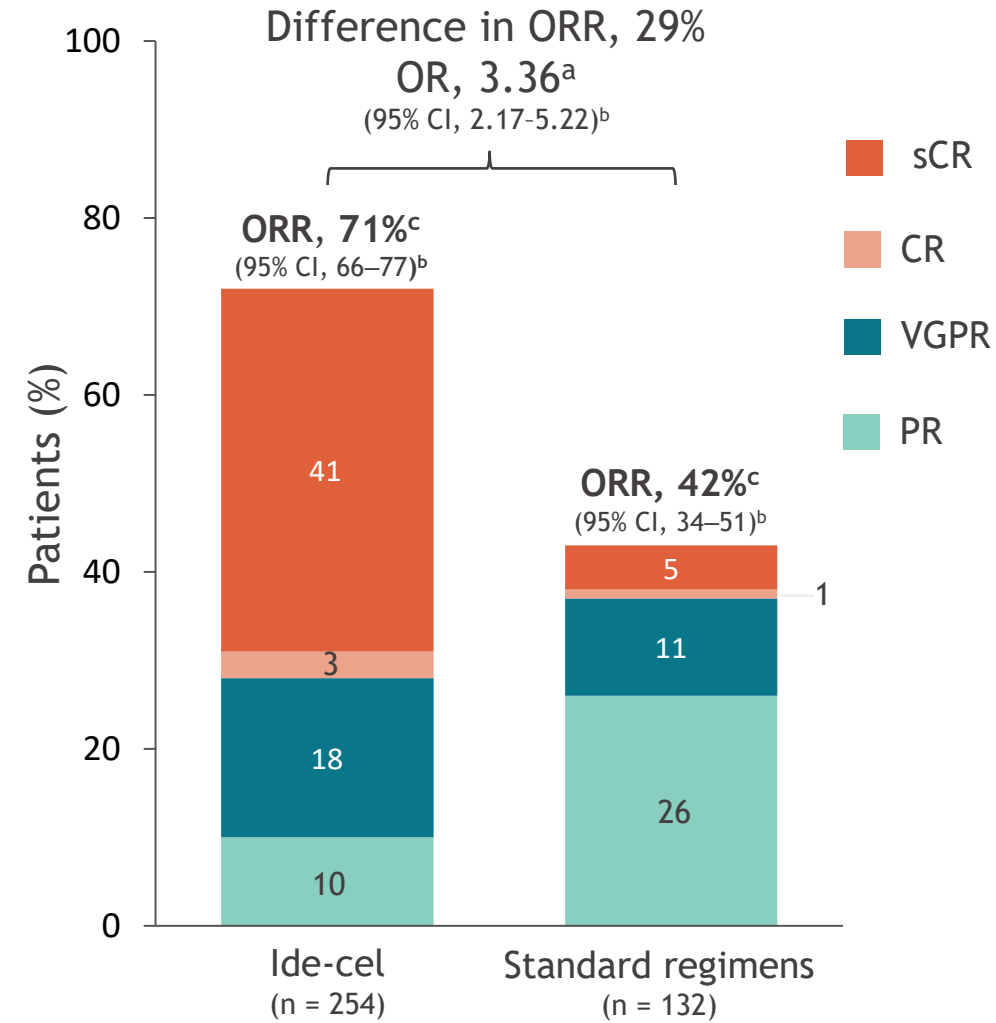


PFS was analyzed in the ITT population of all randomized patients in both arms and included early PFS events occurring between randomization and ide-cel infusion. PFS based on IMWG criteria per IRC. ^aBased on Kaplan-Meier approach; ^bStratified HR based on univariate Cox proportional hazard model. CI is 2-sided.

HR, hazard ratio; ide-cel, idecabtagene vicleucel; IMWG, International Myeloma Working Group; ITT, intent-to-treat; PFS, progression-free survival.

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Deep and durable responses with ide-cel



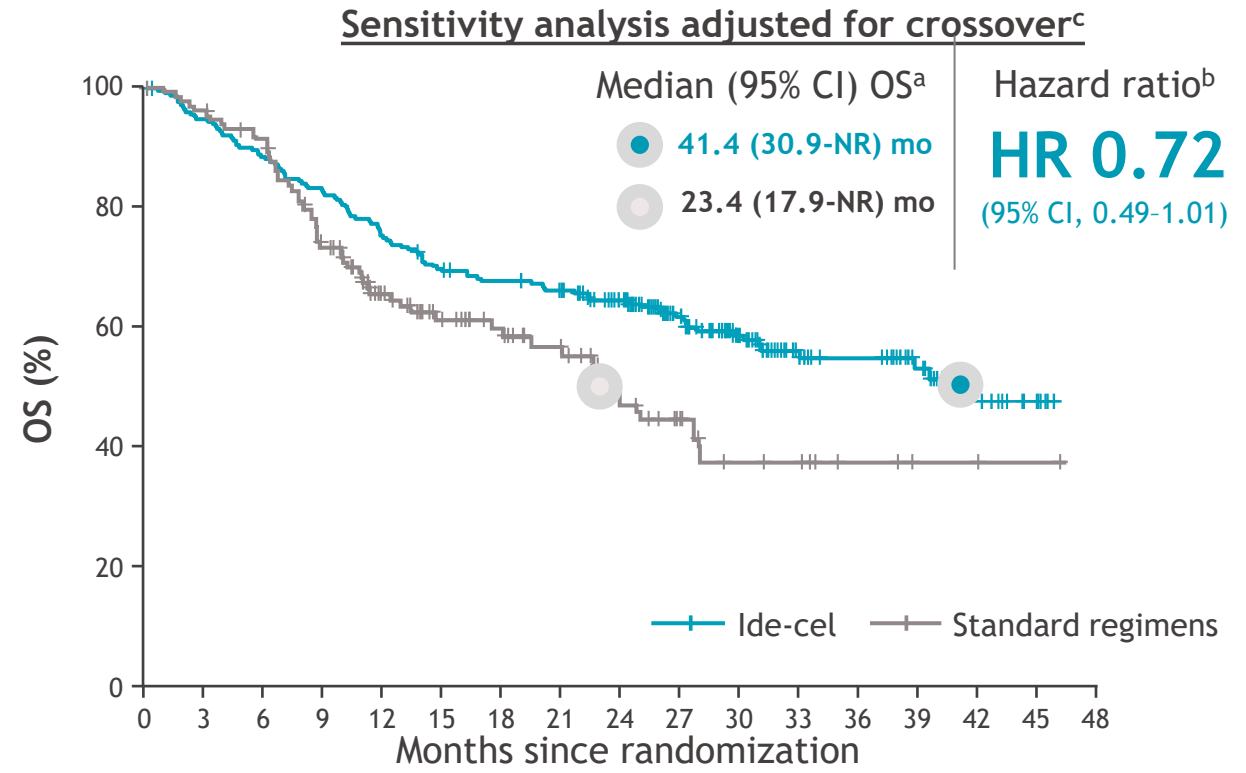
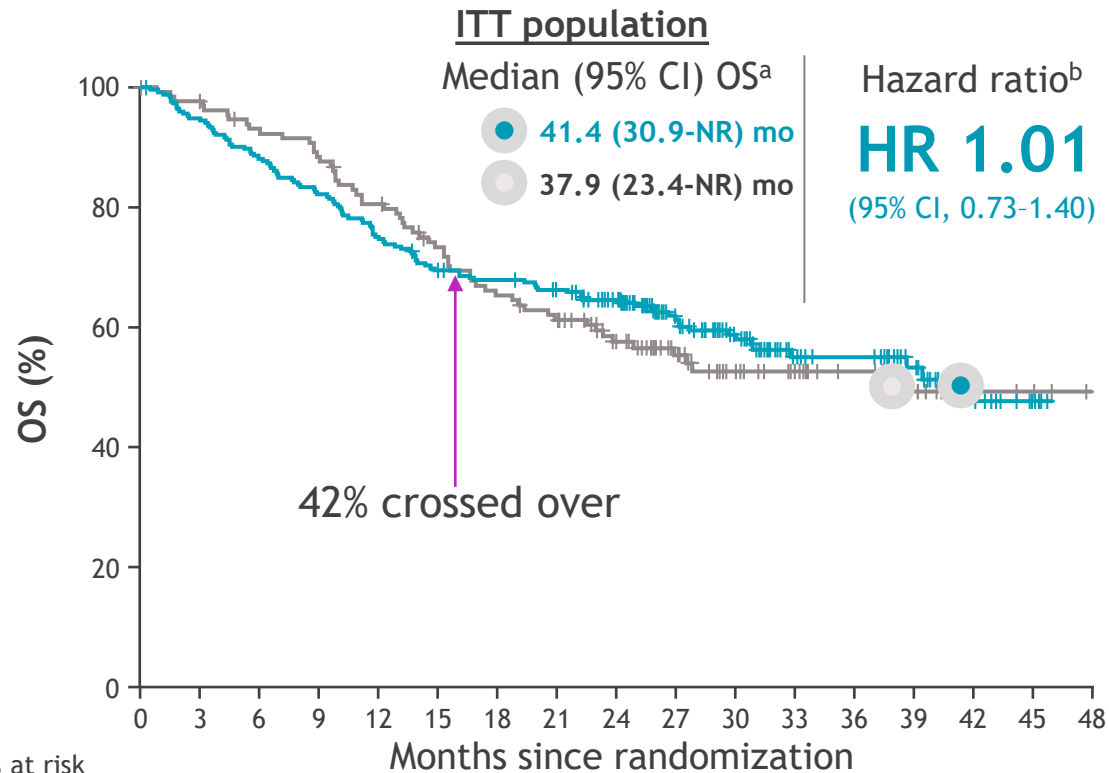
Secondary endpoint	Ide-cel (n = 254)	Standard regimens (n = 132)
CR rate (95 % CI), % ^d	44 (38-50)	5 (2-9)
MRD-negative CR rate, n/N (%) (95% CI) ^e	57/163 (35) (28-42)	1/54 (2) (0-5)
Median (95% CI) DOR, months	16.6 (12.1-19.6)	9.7 (5.5-16.1)
Median PFS2, months	23.5	16.7
HR (95% CI)	0.79 (0.60-1.04)	

Patient disposition

Patients, n (%)	Ide-cel (n = 254)	Standard regimens (n = 132)	Crossover from standard regimens to ide-cel ^a (n = 82)
ITT population^b	254 (100)	132 (100)	-
Underwent leukapheresis	249 (98)	-	82 (62)
Received bridging therapy	212 (83)	-	68 (52)
Did not receive allocated study treatment	29 (11)	6 (5)	8 (6)
Treated population^c	225 (89)	126 (95)	74 (56)
Ongoing in study	136^d (54)	10 (8)	52^e (39)
Ongoing for PFS	53 (21)	7 (5)	NA
Survival follow-up	83 (33)	3 (2)	50 ^f (38)

^aFollowing IRC-confirmed PD. Percentages used the standard regimens ITT population (n = 132) as the denominator; ^bAll randomized patients; ^cPatients who received the study treatment to which they were randomly assigned (identical to the previously reported safety population), percentage calculated based on ITT population; ^dIncluded 3 patients ongoing in survival follow-up who received leukapheresis but did not receive ide-cel infusion; ^eIncluded 2 patients who received leukapheresis but not ide-cel infusion; ^f2 patients are also ongoing in the pretreatment period. ITT, intent-to-treat; NA, not applicable.

OS analysis confounded by substantial crossover



Patients at risk

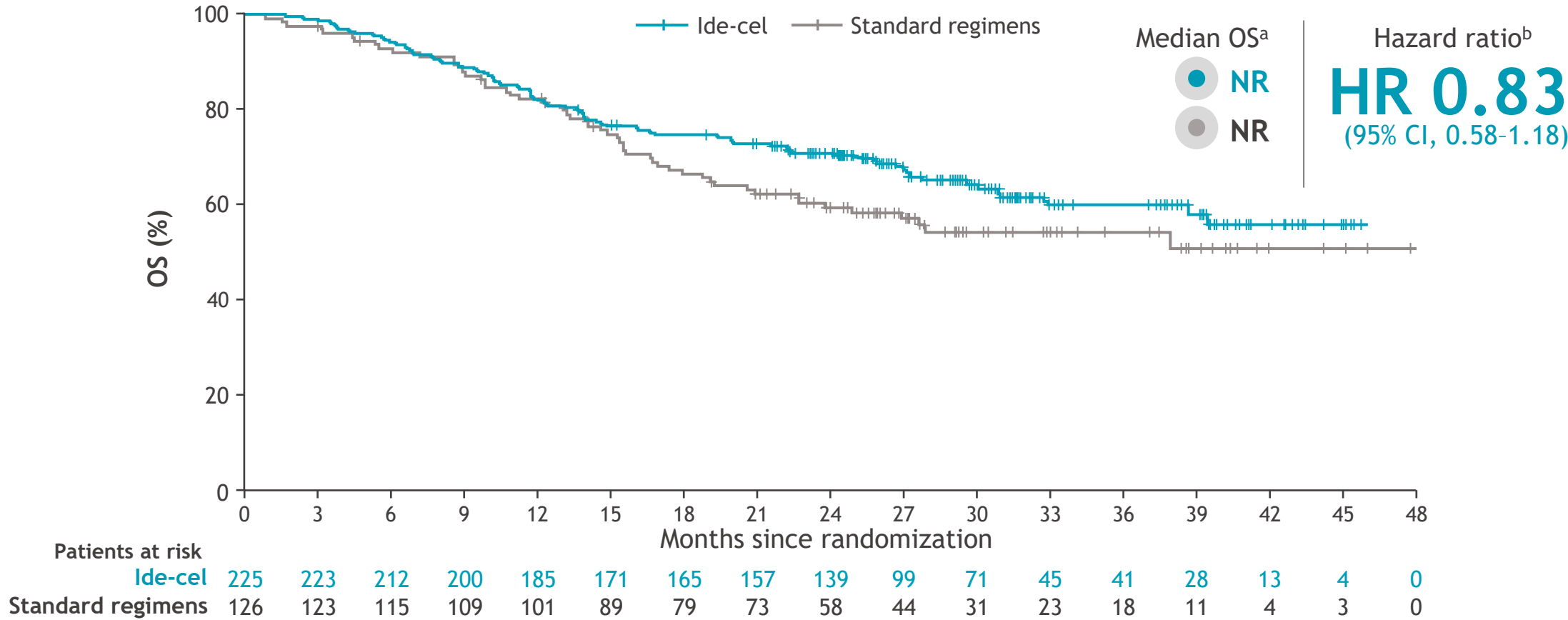
	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
Ide-cel	254	240	223	208	190	175	169	161	143	103	75	48	44	30	13	4	0
Standard regimens	132	128	120	114	103	91	81	75	59	45	32	24	18	11	4	3	0

	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
Ide-cel	254	240	223	208	190	175	169	161	143	103	75	48	44	30	13	4	0
Standard regimens	132	126	118	93	67	50	42	34	21	14	9	8	4	2	1	1	0

More than half of patients in standard regimens arm received ide-cel as subsequent therapy upon confirmed PD and the majority received ide-cel within 3-16 months of randomization

Prespecified crossover-adjusted analysis shows OS benefit of ide-cel

Trend of OS benefit with ide-cel among treated patients



- This is an exploratory analysis of the treated population without adjusting for crossover

Safety profile of ide-cel remained consistent

Treated population, n (%)	Ide-cel (n = 225)	Standard regimens (n = 126)
Any-grade AE	225 (100)	124 (98)
Serious AE	105 (47)	52 (41)
ITT population, n (%)	Ide-cel (n = 254)	Standard regimens (n = 132)
Overall deaths	106 (42)	58 (44)
Cause of death		
Disease progression	64 (25)	37 (28)
AEs	17 (7)	8 (6)
Other causes	23 (9)	12 (9)
SPMs ^a	2 (1)	1 (1)

Treated population, n (%)	Ide-cel (n = 225)
CRS ^b	
Any grade	197 (88)
Grade 3/4	9 (4)
iiNT ^c	
Any grade	34 (15)
Grade 3/4	7 (3)
Infections	
Any grade	125 (56)
Grade 3/4	50 (22)

- There were no new CRS or iiNT events with ide-cel since the interim analysis¹ and no parkinsonism or Guillain-Barré syndrome were reported
- **No SPMs of T-cell origin were reported in the ide-cel arm**
- No new safety signals

^aDeaths due to SPMs in the ide-cel arm were leukemia (n = 1) and pancreatic adenocarcinoma (n = 1); death due to SPMs in the standard regimens arm was malignant neoplasm of unknown primary site (n = 1); ^bCRS was graded according to modified Lee's criteria;² maximum-grade events are reported, patients could have >1 event; ^cIncludes immune effector cell-associated neurotoxicity syndrome reported by investigator as a neurologic toxicity.

AE, adverse event; CRS, cytokine release syndrome; ide-cel, idecabtagene vicleucel; iiNT, investigator-identified neurotoxicity; ITT, intent-to-treat; SPM, second primary malignancy.

1. Rodríguez-Otero P, et al. *N Engl J Med* 2023;388:1002-1014; 2. Lee DW, et al. *Blood*. 2014;124:188-195.

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Secondary Cancers after Chimeric Antigen Receptor T-Cell Therapy

Nicole Verdun, M.D., and Peter Marks, M.D., Ph.D.

Since the first such product was approved in 2017, chimeric antigen receptor (CAR) T-cell therapies have become important treatments for relapsed or refractory hematologic cancers, and

the six products involving autologous CAR T cells that have been approved in the United States now cover a range of indications spanning relapsed or refractory B-cell acute lymphoblastic leukemia, B-cell non-Hodgkin's lymphomas, and multiple myeloma (see table). In addition, numerous autologous and allogeneic CAR-T products are in development. Manufacturers of these next-generation products are seeking to improve on the efficacy and safety profile of existing therapies for hematologic cancers and to target solid tumors. CAR T cells are also under investigation for the treatment of nonmalignant conditions, such as autoimmune diseases.¹

The demonstrated efficacy of

the current generation of approved CAR-T products comes along with several well-described safety concerns that are noted in the products' labeling, including risks of cytokine release syndrome, immune effector cell-associated neurotoxicity syndrome, various forms of cytopenia, and hypogammaglobulinemia. Better understanding of some of these risks has led to improved outcomes, such as for patients who develop cytokine release syndrome.²

All currently approved CAR-T products employ T cells that are produced by using viral transduction to transfer the genetic construct. Given the relatively recent deployment of these therapies, the

Food and Drug Administration (FDA) has issued draft guidance recommending that people who receive CAR T cells engineered with integrating vectors be monitored for extended periods for adverse events, including cancers.³ Although CAR-T products have to date been associated with fewer cancers than products made with the previous generation of viruses used for gene therapy transduction, the potential for oncogenesis caused by genomic integration or other mechanisms still exists with the current generation of retroviral vectors. For instance, the lentiviral vector constructs, despite integrating in a semirandom fashion into the genome, have affinity for areas of the genome in which active gene expression is taking place, which may pose a risk for insertional oncogenesis.⁴

As of December 31, 2023, the FDA had become aware of 22 cases of T-cell cancers that occurred after treatment with CAR-T prod-

Chimeric Antigen Receptor T-Cell Products Approved in the United States.*				
Brand Name	Generic Name	Manufacturer	Year Initially Approved	Indications (Relapsed or Refractory Disease)
Kymriah	Tisagenlecleucel	Novartis Pharmaceuticals	2017	Pediatric or young-adult B-cell ALL, large B-cell lymphoma, follicular lymphoma
Yescarta	Axicabtagene ciloleucel	Kite Pharma	2017	Large B-cell lymphoma
Tecartus	Brexucabtagene autoleucel	Kite Pharma	2020	B-cell ALL, mantle-cell lymphoma
Breyanzi	Lisocabtagene maraleucel	Juno Therapeutics/Bristol Myers Squibb	2021	Large B-cell lymphoma, primary mediastinal large B-cell lymphoma, follicular lymphoma
Abecma	Idecabtagene vicleucel	Celgene/Bristol Myers Squibb	2021	Multiple myeloma
Carvykti	Ciltacabtagene autoleucel	Janssen Biotech	2022	Multiple myeloma

* ALL denotes acute lymphoblastic leukemia.

ucts. Such cancers have included T-cell lymphoma, T-cell large granular lymphocytosis, peripheral T-cell lymphoma, and cutaneous T-cell lymphoma. Among the 14 cases for which adequate data are currently available, the cancers have manifested within 2 years after administration of CAR T cells (range, 1 to 19 months), with roughly half occurring within the first year after administration. Cases have been reported in conjunction with five of the six available CAR-T products, but the small number of cases and variation in product use preclude conclusions about the strength of an association with any specific product. Some of these cases are still under investigation.

In three cases for which genetic sequencing has been performed to date, the CAR transgene has been detected in the malignant clone, which indicates that the CAR-T product was most likely involved in the development of the T-cell cancer. With more than 27,000 doses of the six approved products having been administered in the United States, the overall rate of T-cell cancers among people

receiving CAR-T therapies appears to be quite low, even if all reported cases are assumed to be related to treatment. But relying on postmarketing reporting may lead to underestimates of such cases.

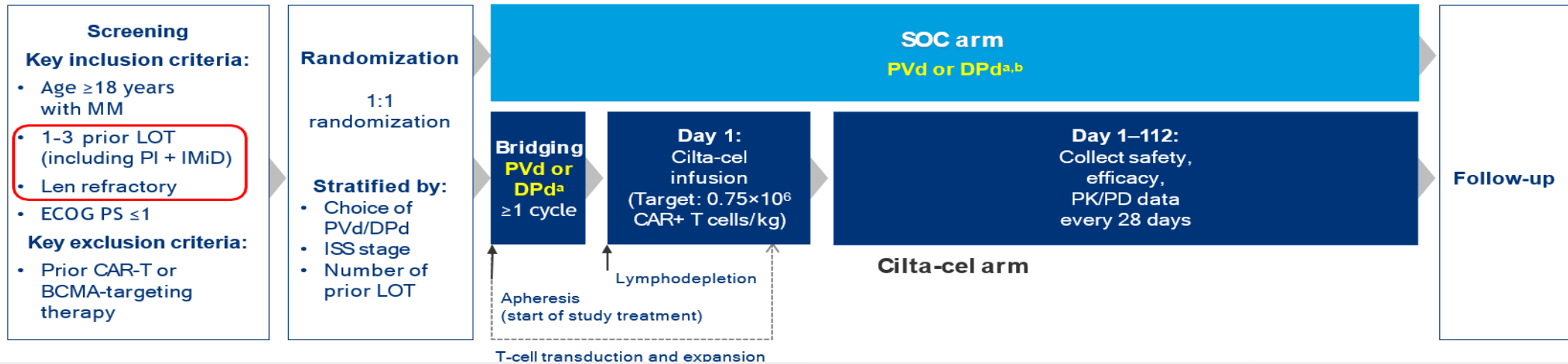
The FDA is attempting to gather as much information as possible on each of the reported cases, but in many instances, adequate samples of the lymphomas have not been retained for testing by means of polymerase chain reaction or genome sequencing. Determination of whether the T-cell cancer is associated with the CAR construct therefore most likely won't be possible for every case reported to date. The FDA plans to provide updates as substantive new information becomes available.

It is important for clinicians caring for people who have received CAR T cells to report the occurrence of any new cancer. At this time, we recommend that patients and clinical trial participants who receive treatment with these products be monitored for new cancers throughout their lives, since — owing to the relatively recent widespread introduc-

tion of CAR-T products into clinical care — we don't yet know how long after treatment people remain at risk for these adverse events. If a new cancer occurs after treatment with one of these products, clinicians should contact the manufacturer to report the event and obtain instructions on the collection of patient samples for testing for the presence of the CAR transgene. Clinicians are also encouraged to report such T-cell cancers to the FDA by contacting us at 1-800-FDA-1088 or visiting the website for our medical product safety reporting program (<http://www.fda.gov/medwatch>).

Moving forward, particularly as the use of CAR T cells for indications outside hematology and oncology is considered, new strategies involving targeting insertion of the CAR construct to specific loci might help reduce the risk of cancers due to integration of the CAR construct at oncogenic loci within the genome.⁵ Comprehensive tumor-testing strategies might also generate information on the risk for and nature of these cancers and provide additional mechanistic insights. For now, second-

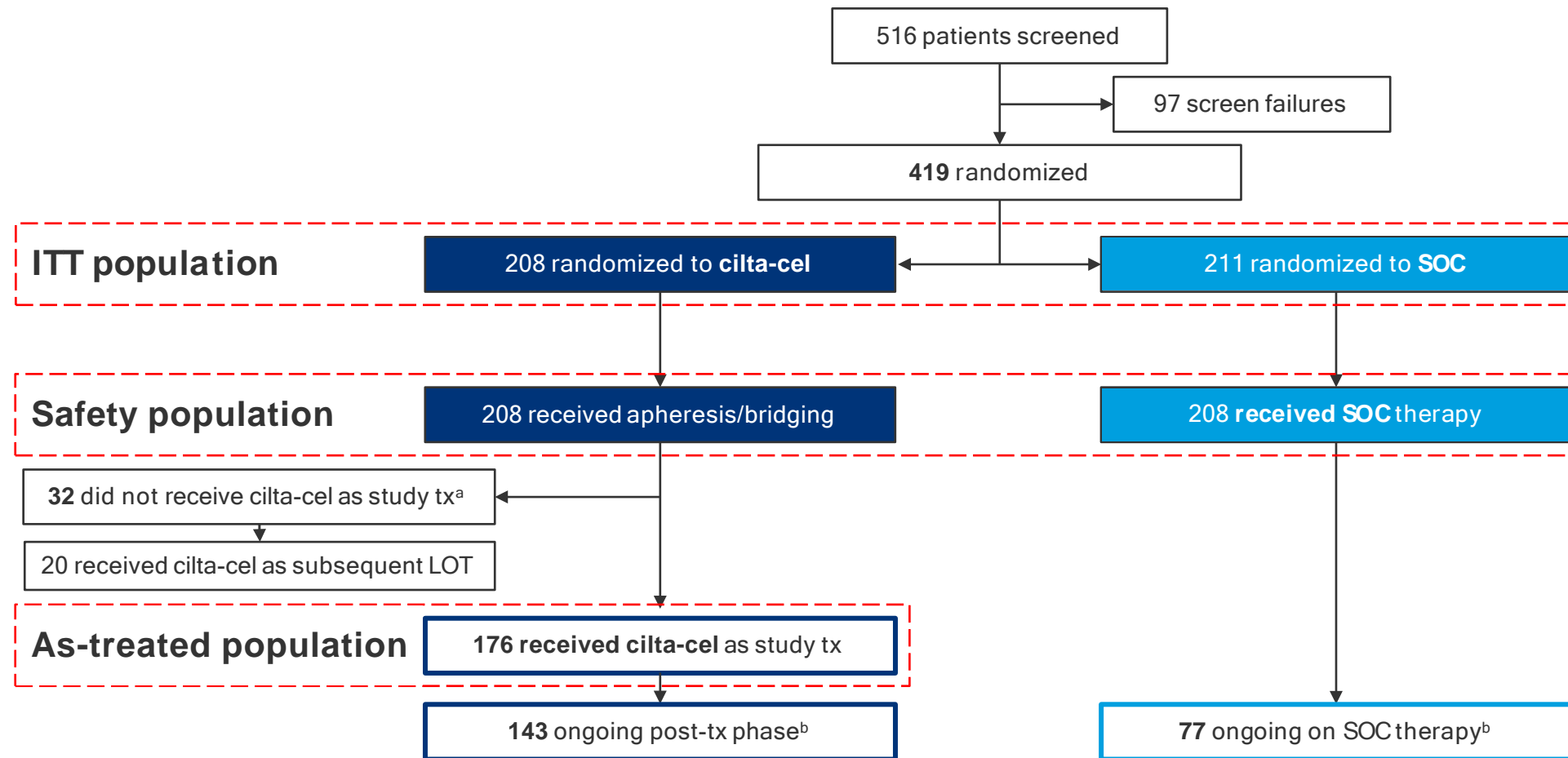
CARTITUDE-4: study design and baseline characteristics



Baseline characteristic	ITT population	
	Cilta-cel (n=208)	SOC (n=211)
Age, median (range), years	61.5 (27-78)	61.0 (35-80)
Male, n (%)	116 (55.8)	124 (58.8)
White, n (%)	157 (75.5)	157 (74.4)
ECOG PS ≤ 1 , n (%) ^{a,b}	207 (99.5)	210 (99.5)
ISS stage, n (%)		
I	136 (65.4)	132 (62.6)
II	60 (28.8)	65 (30.8)
III	12 (5.8)	14 (6.6)
Bone marrow plasma cells $\geq 60\%$, ^c n (%)	42 (20.4)	43 (20.7)
Presence of soft tissue plasmacytomas, ^d n (%)	44 (21.2)	35 (16.6)
Years since diagnosis, median (range)	3 (0.3-18.1)	3.4 (0.4-22.1)
Prior LOT, median (range)	2 (1-3)	2 (1-3)
1 prior LOT, n (%)	68 (32.7)	68 (32.2)
2 or 3 prior LOT, n (%)	140 (67.3)	143 (67.8)

Baseline characteristic	ITT population	
	Cilta-cel (n=208)	SOC (n=211)
Cytogenetic high risk, n (%) ^e	123 (59.4)	132 (62.9)
del(17p)	49 (23.7)	43 (20.5)
t(14;16)	3 (1.4)	7 (3.3)
t(4;14)	30 (14.5)	30 (14.3)
gain/amp(1q)	89 (43.0)	107 (51.0)
2 or more high-risk cytogenetic features	43 (20.8)	49 (23.3)
del(17p), t(14;16), or t(4;14)	73 (35.3)	69 (32.9)
Triple-class ^f exposed, n (%)	53 (25.5)	55 (26.1)
Penta-drug ^g exposed, n (%)	14 (6.7)	10 (4.7)
Refractory status, n (%)		
Triple-class refractory ^{f,h}	30 (14.4)	33 (15.6)
Bortezomib	55 (26.4)	48 (22.7)
Pomalidomide	8 (3.8)	9 (4.3)
Daratumumab	48 (23.1)	45 (21.3)
Any PI	103 (49.5)	96 (45.5)

CARTITUDE-4: Patient Population and Follow-Up



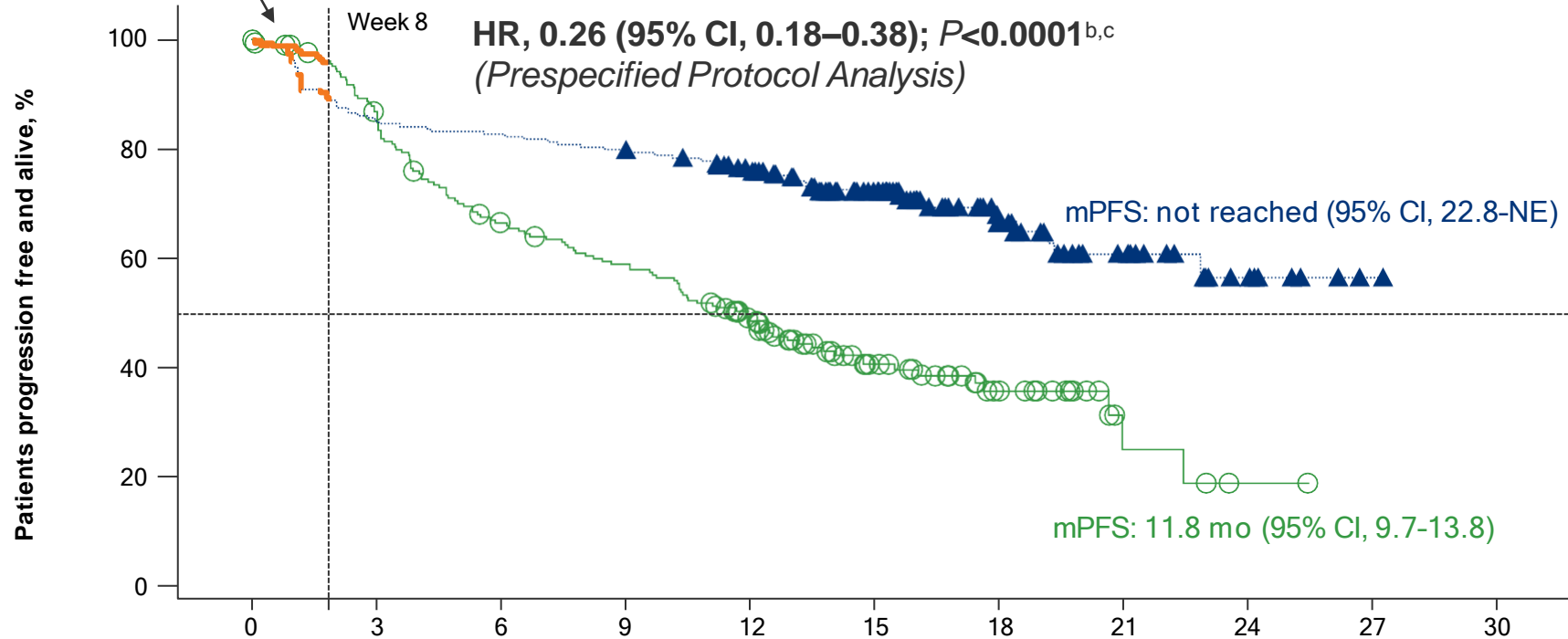
- At November 1, 2022, data cut-off, **median follow-up was 15.9 months** (range, 0.1-27)
- First patient randomized on July 10, 2020, and last patient randomized on November 17, 2021
- **Median time from first apheresis to cilta-cel infusion was 79 days**

^aDue to disease progression (n=30) or death (n=2) during bridging therapy/lymphodepletion. ^bHave not progressed. cilta-cel, ciltacabtagene autoleucel; ITT, intent-to-treat; LOT, line of therapy; SOC, standard of care; tx, treatment.

CARTITUDE-4: PFS (ITT Population)

Bridging phase, patients in cilta-cel arm were receiving the same treatment as the SOC arm

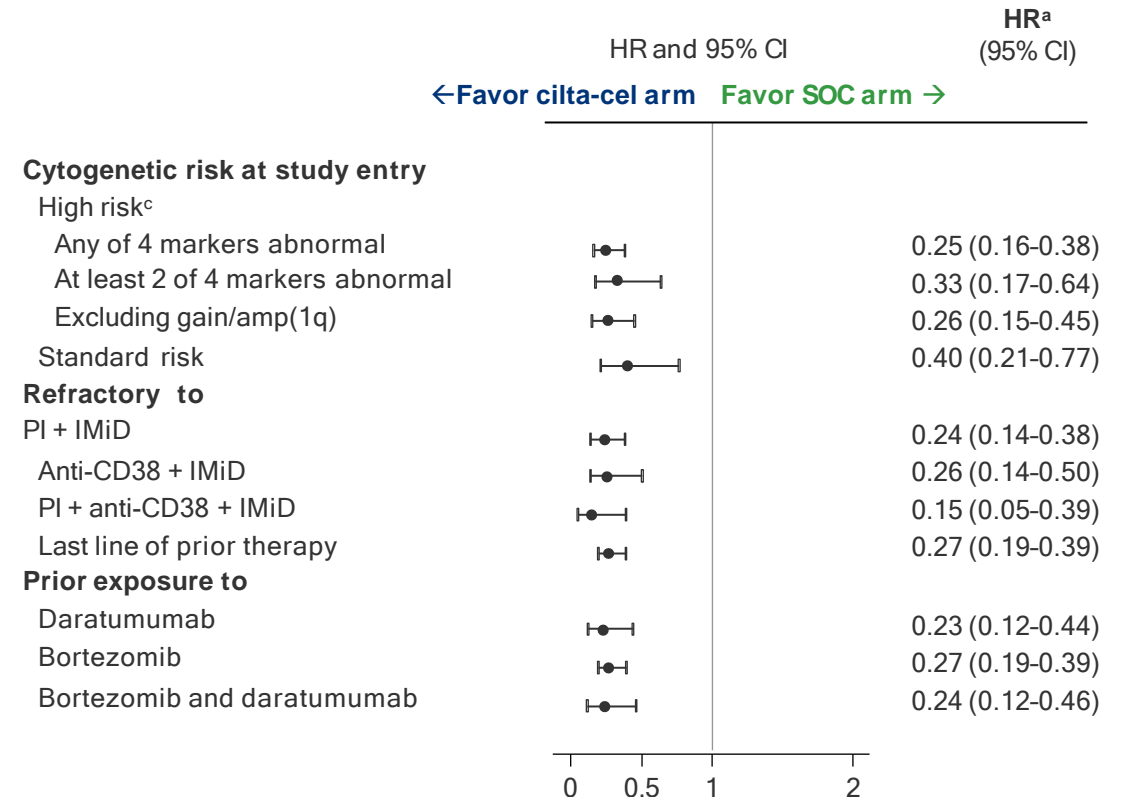
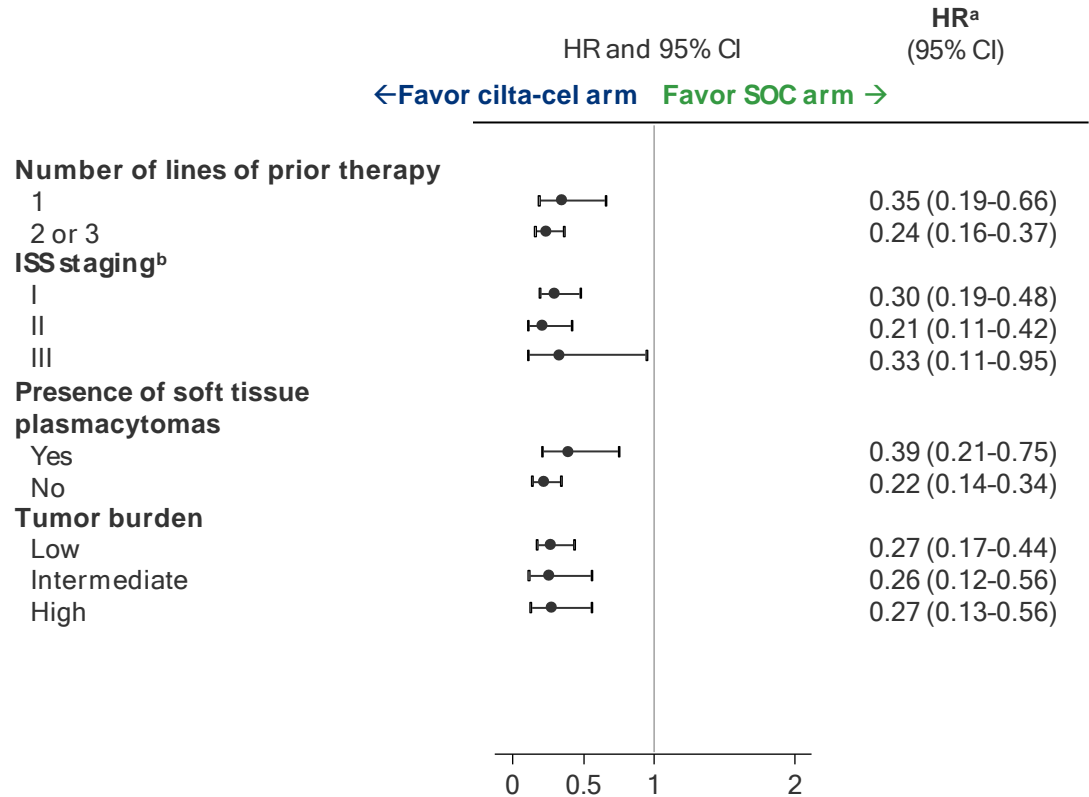
Progression-free survival^a



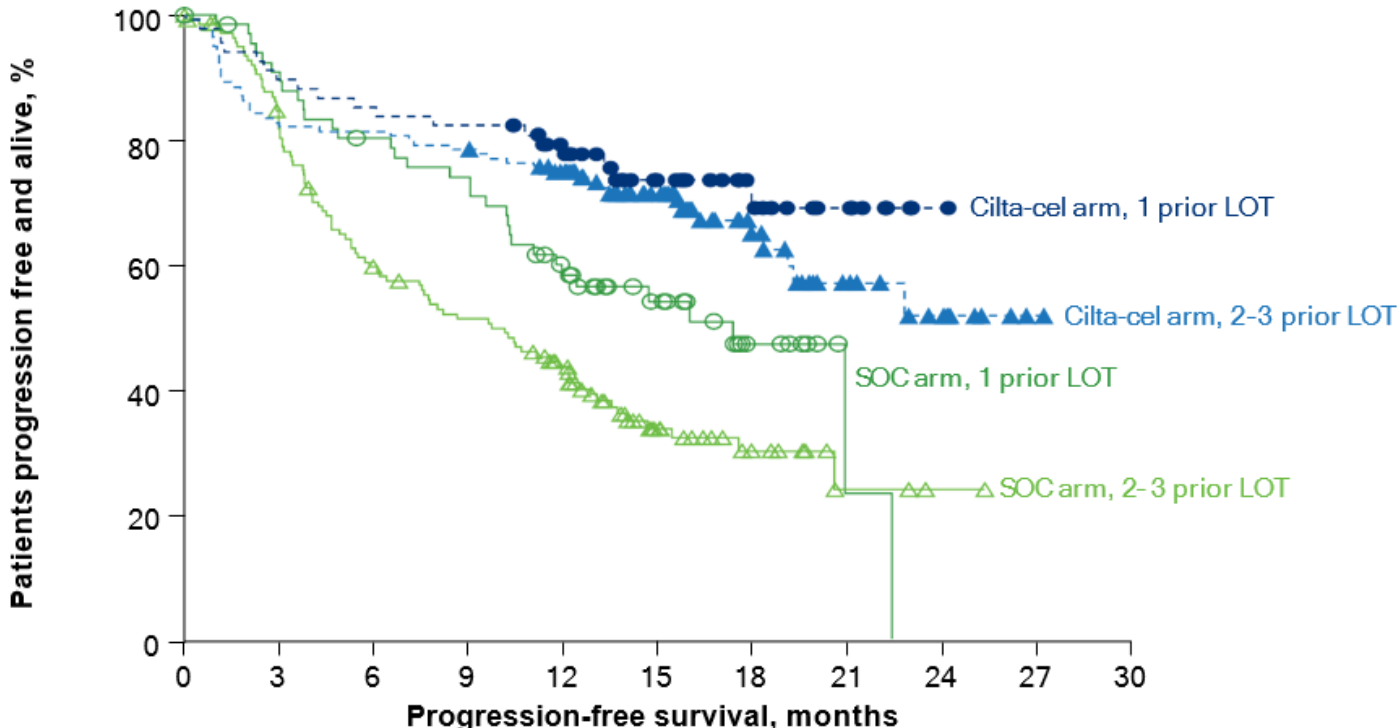
No. at risk	0	3	6	9	12	15	18	21	24	27	30
Cilta-cel arm	208	177	172	166	146	94	45	22	9	1	0
SOC arm	211	176	133	116	88	46	20	4	1	0	0

▲ Cilta-cel arm ○ SOC arm

PFS: Key Subgroup Analysis (ITT)



CARTITUDE-4: PFS by prior LoT

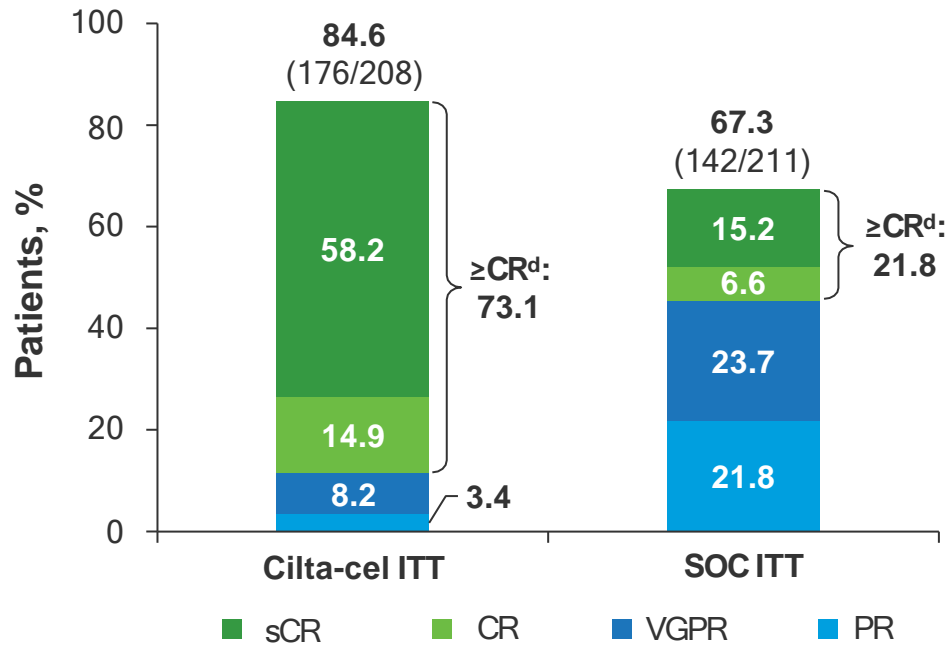


	0	3	6	9	12	15	18	21	24	27	30
No. at risk											
Cilta-cel arm, 1 prior LoT	68	61	58	56	48	28	16	8	1	0	0
Cilta-cel arm, 2-3 prior LoT	140	116	114	110	98	66	29	14	8	1	0
SOC arm, 1 prior LoT	68	60	52	48	35	22	8	1	0	0	0
SOC arm, 2-3 prior LoT	143	116	81	68	53	24	12	3	1	0	0

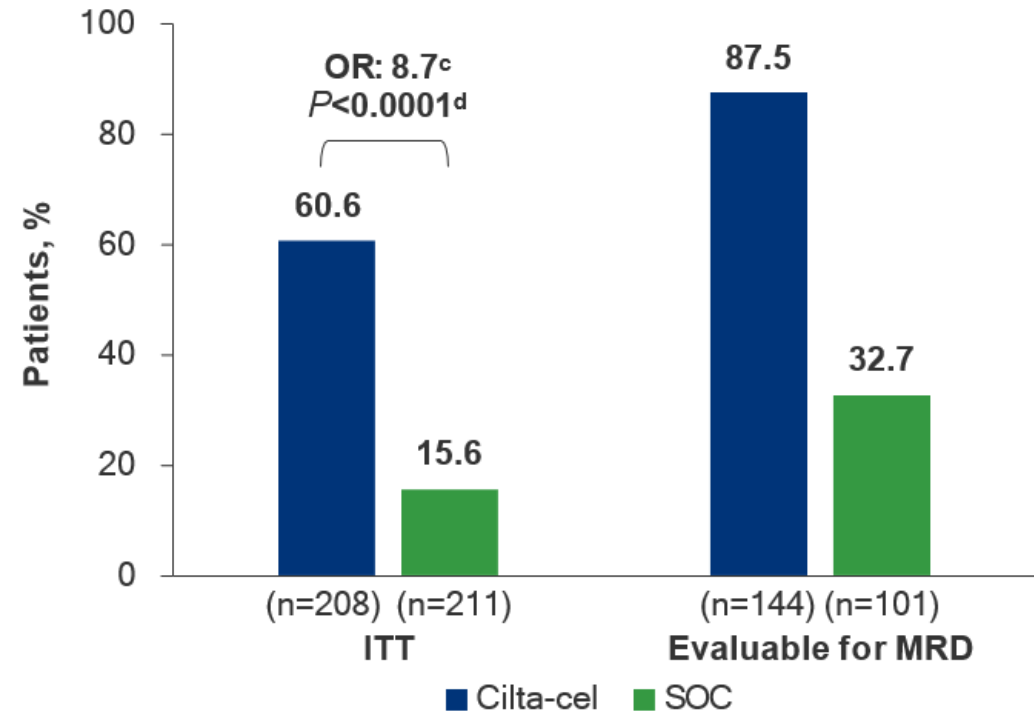
ORR and MRD negativity rates

Overall response rate^{a,b,c}

Odds ratio:
3.0 (1.8-5.0); $P < 0.0001$



MRD negativity^b



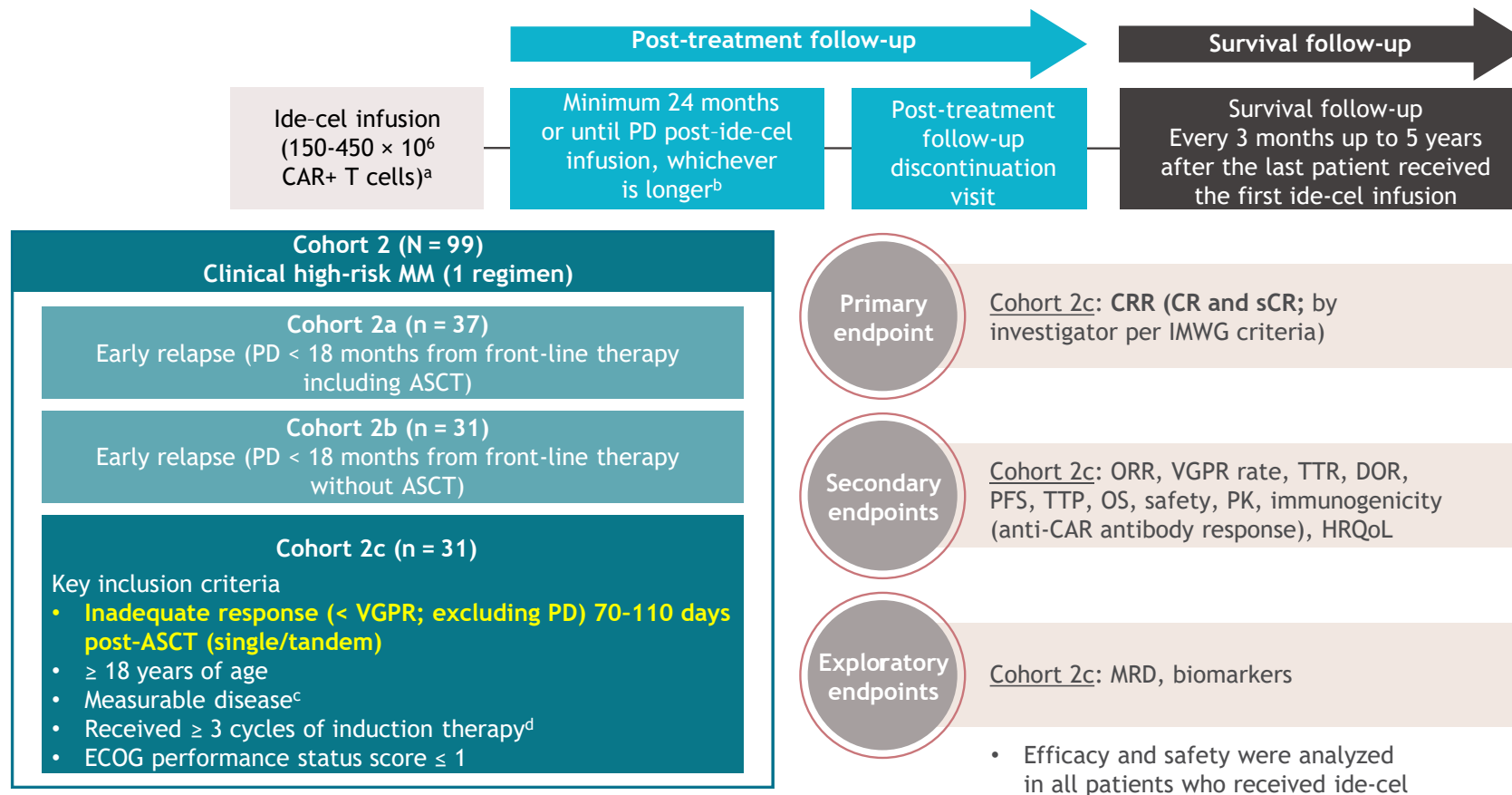
TEAEs, CRS and CAR-T-Related Neurotoxicity

Select TEAE ≥15%, n (%)	Safety population				AEs, n (%)	As-treated patients (n=176)				
	Cilta-cel (n=208)		SOC (n=208)			Any grade	Grade 3/4	Median time to onset, days	Median duration, days	Resolved, n
	Any grade	Grade 3/4	Any grade	Grade 3/4						
Any AE	208 (100)	201 (96.6)	208 (100)	196 (94.2)	CRS	134 (76.1)	2 (1.1)	8	3	134
Serious AE	92 (44.2)	67 (32.2)	81 (38.9)	70 (33.7)	Neurotoxicity ^a	36 (20.5)	5 (2.8)			
Hematologic	197 (94.7)	196 (94.2)	185 (88.9)	179 (86.1)	ICANS	8 (4.5)	0 ^b	10	2	8
Neutropenia	187 (89.9)	187 (89.9)	177 (85.1)	171 (82.2)	Other ^c	30 (17.0)	4 (2.3)			
Anemia	113 (54.3)	74 (35.6)	54 (26.0)	30 (14.4)	Cranial nerve palsy ^d	16 (9.1)	2 (1.1)	21	77	14
Thrombocytopenia	113 (54.3)	86 (41.3)	65 (31.3)	39 (18.8)	Peripheral neuropathy	5 (2.8)	1 (0.6)	63	201	3
Lymphopenia	46 (22.1)	43 (20.7)	29 (13.9)	25 (12.0)	MNT	1 (0.6)	0	85	-	0
Infections	129 (62.0)	56 (26.9)	148 (71.2)	51 (24.5)						
Upper respiratory tract ^a	39 (18.8)	4 (1.9)	54 (26.0)	4 (1.9)						
Lower respiratory tract ^b	19 (9.1)	9 (4.3)	36 (17.3)	8 (3.8)						
COVID-19 ^c	29 (13.9)	6 (2.9)	55 (26.4)	12 (5.8)						

In the cilta-cel as-treated population:

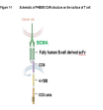
- 30 patients had non-ICANS neurotoxicities^c
 - 16 cranial nerve palsies (14 recovered)
 - 5 peripheral neuropathies
 - 1 MNT (grade 1)
- **Lower incidence and severity of CRS, ICANS, MNTs, and some cytopenias^e observed with CARTITUDE-4 vs CARTITUDE-1**
 - Cilta-cel may be better tolerated when used earlier in treatment
 - Effective bridging therapy enables better control of tumor burden prior to CAR-T infusion
 - MNTs were lower likely related to patient management strategies implemented to mitigate this risk

KarMMa-2 cohort 2: ide-cel for “functional” HR MM

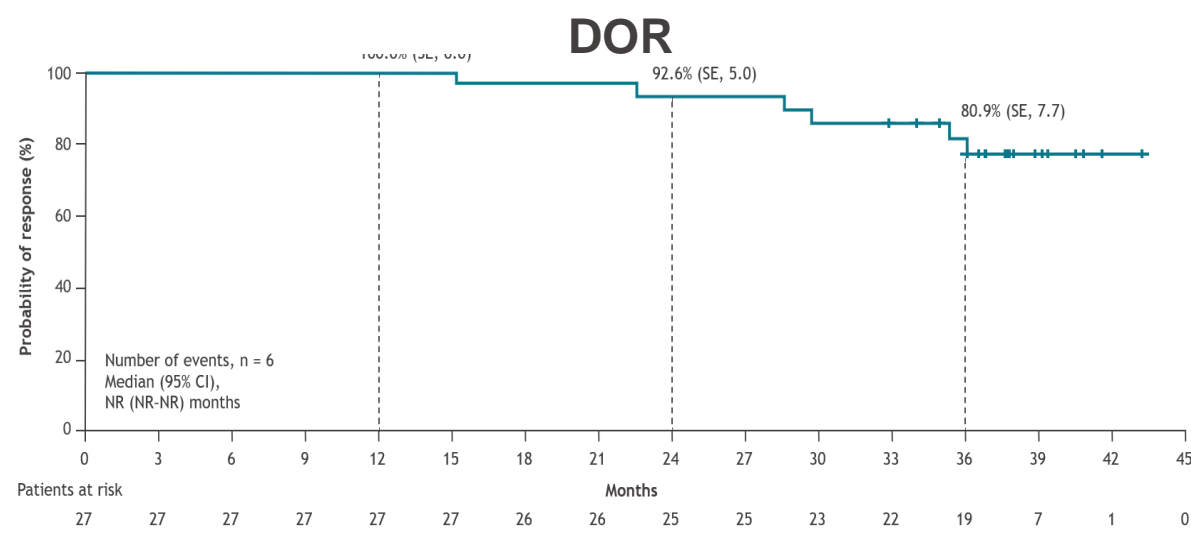
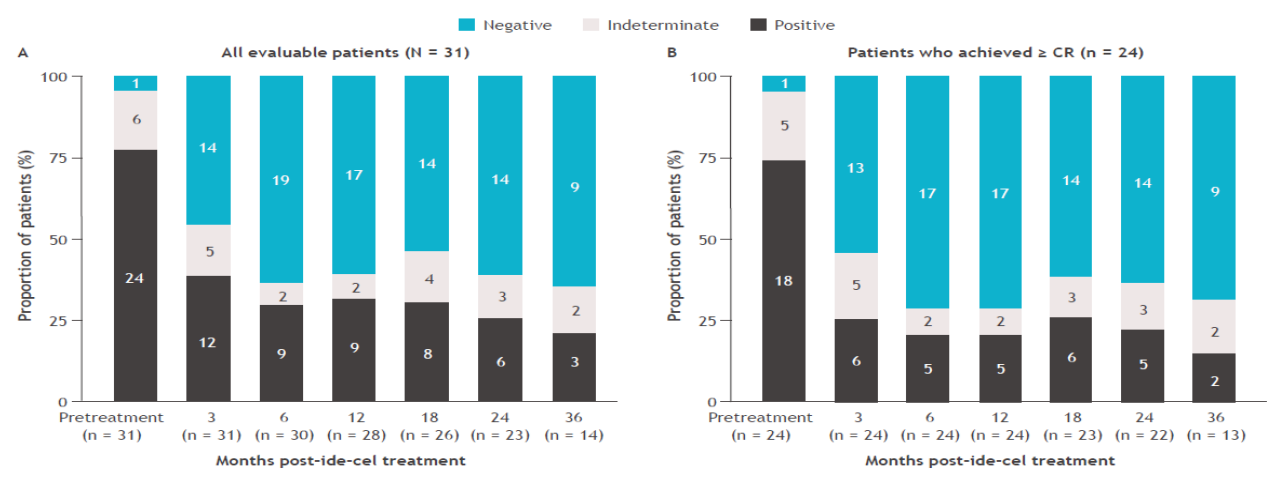
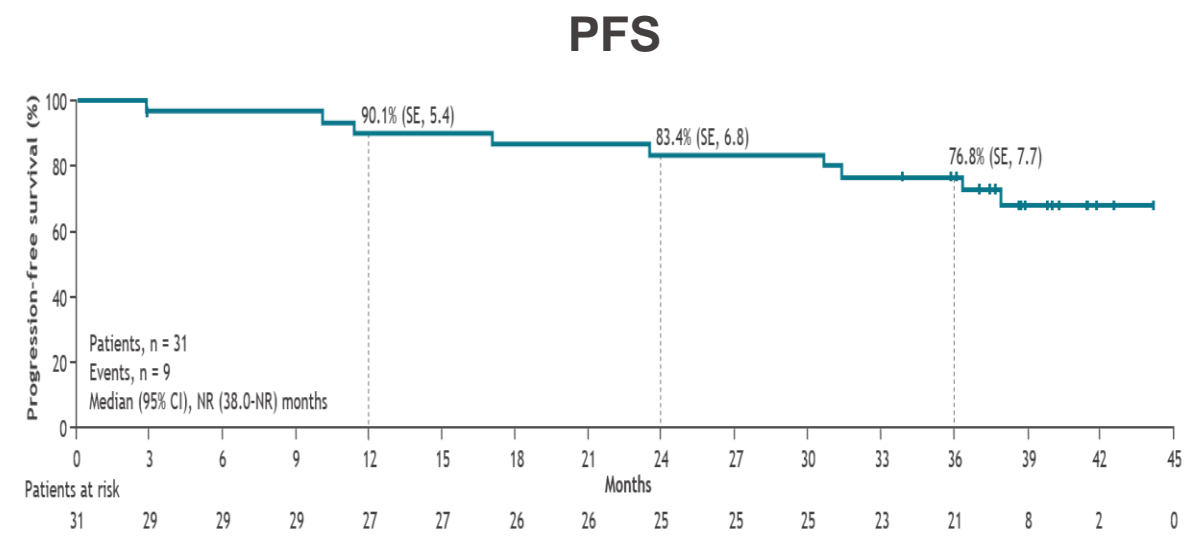
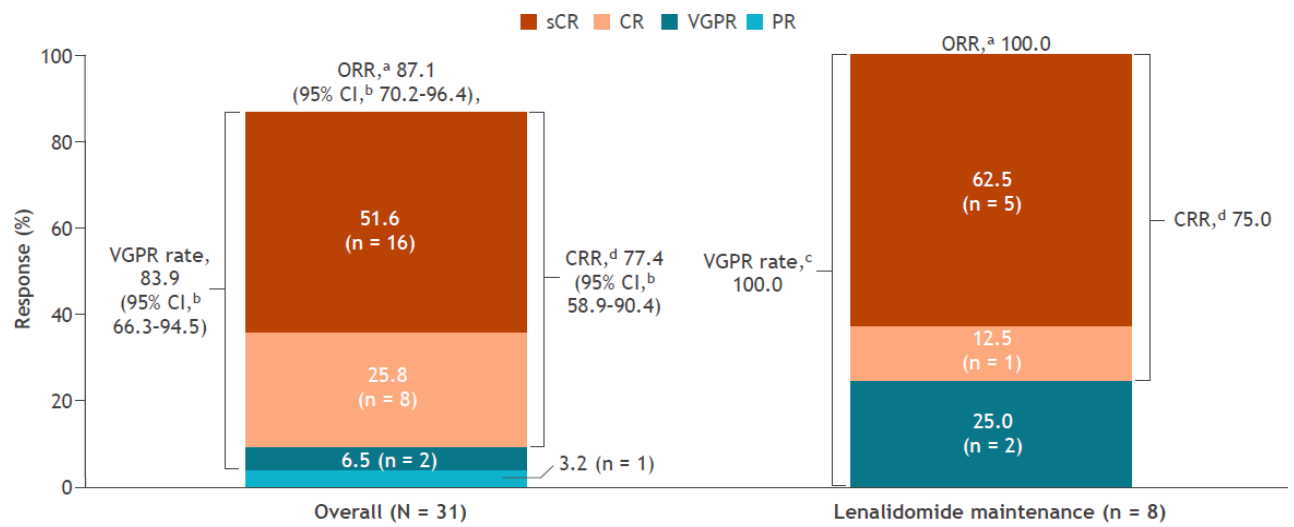


^aAfter lymphodepletion (cyclophosphamide 300 mg/m² + fludarabine 30 mg/m² × 3), patients received a single infusion of ide-cel at a range of 150-450 × 10⁶ CAR+ T cells (up to an additional 20%; 20% over the protocol-specified dose constituted overdose); ^bAt investigator discretion, patients could receive maintenance treatment post-infusion; ^cMeasurable disease determined by M protein (serum protein electrophoresis ≥ 0.5 g/dL or urine protein electrophoresis ≥ 200 mg/24 hours) and/or light chain MM without measurable disease in serum or urine (serum immunoglobulin free light chain ≥ 10 mg/dL and abnormal serum immunoglobulin κ:λ free light chain ratio); ^dMust contain a PI, an IMiD[®] agent, and dexamethasone.

ASCT, autologous stem cell transplantation; CAR, chimeric antigen receptor; CR, complete response; CRR, complete response rate; DOR, duration of response; ECOG, Eastern Cooperative Oncology Group; HRQoL, health-related quality of life; ide-cel, idecabtagene vicleucel; IMiD, immunomodulatory drug; IMWG, International Myeloma Working Group; MM, multiple myeloma; MRD, minimal residual disease; ORR, overall response rate; OS, overall survival; PD, progressive disease; PFS, progression-free survival; PI, proteasome inhibitor; PK, pharmacokinetics; sCR, stringent complete response; TTP, time to progression; TTR, time to response; VGPR, very good partial response.



KarMMa-2 cohort 2c: clinical outcomes



Summary

- **Ide-cel and cilta-cel significantly improved PFS vs SOC in patients with early lines of RRMM**
 - ✓ PFS benefit across many prespecified subgroups
- **Both ide-cel and cilta-cel significantly increased the ORR and depth of response vs SOC**
- **Relevance of the most effective bridging therapy**
- **The safety profile of ide-cel and cilta-cel was manageable and consistent with prior studies in later LoT**