

CAR T-Cell Therapy Directory

Comparison of chimeric antigen receptor (CAR) T-cell therapies by disease state.

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Educational reference only. Verify the current full prescribing information and institutional cellular therapy procedures before clinical use. Cross-trial safety rates and manufacturing intervals are not directly comparable because study populations, definitions, grading systems, assessment windows and manufacturing time points differ.

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Table 1. CAR T-Cell Therapies in B-Cell Acute Lymphoblastic Leukemia (ALL)

Agent	Tisagenlecleucel (KYMRIAH®)	Brexucabtagene autoleucel (TECARTUS®)	Obecabtagene autoleucel (AUCATZYL®)
Manufacturer	Novartis Pharmaceuticals Corporation (distributor)	Kite Pharma, Inc.	Autolus Limited
Target/Construct	CD19; 4-1BB; CD3ζ; lentiviral vector	CD19; CD28; CD3ζ; retroviral vector	CD19; 4-1BB; CD3ζ; lentiviral vector
Indication(s)	Patients up to 25 years of age with B-cell precursor ALL that is refractory or in second or later relapse	Adults with relapsed or refractory B-cell precursor ALL	Adults with relapsed or refractory B-cell precursor ALL
Route of Administration	IV; single infusion	IV; single infusion	IV; split-dose infusion on Day 1 and Day 10 (±2 days)
CAR T-Cell Dose	≤50 kg: 0.2–5.0 × 10 ⁶ CAR-positive viable T cells/kg; >50 kg: 0.1–2.5 × 10 ⁸ CAR-positive viable T cells	1 × 10 ⁶ CAR-positive viable T cells/kg; maximum 1 × 10 ⁸ CAR-positive viable T cells	Total: 410 × 10 ⁶ CD19 CAR-positive viable T cells. Bone marrow blasts >20%: Day 1, 10 × 10 ⁶ ; Day 10, 400 × 10 ⁶ . Bone marrow blasts ≤20%: Day 1, 100 × 10 ⁶ ; Day 10, 310 × 10 ⁶ .
Lymphodepleting Chemotherapy	Fludarabine 30 mg/m ² IV daily for 4 days + cyclophosphamide 500 mg/m ² IV daily for 2 days, starting with the first fludarabine dose	Fludarabine 25 mg/m ² IV on Days –4, –3, and –2 + cyclophosphamide 900 mg/m ² IV on Day –2	Fludarabine 30 mg/m ² IV daily for 4 days + cyclophosphamide 500 mg/m ² IV daily for 2 days, starting with the first fludarabine dose
Infusion Timing	2–14 days after completion of lymphodepletion	Day 0 after lymphodepletion on Days –4, –3, and –2	Dose 1: 3 days (±1 day) after lymphodepletion, with a minimum 48-hour washout; Dose 2: Day 10 (±2 days); may be postponed or discontinued based on toxicity
Manufacturing/Availability Time	About 3–4 weeks from receipt of cells at the manufacturing site to shipment back to the health care provider	Leukapheresis to product delivery, median 16 days (range, 11–39 days); leukapheresis to infusion, median 29 days (range, 20–60 days)	Leukapheresis to product release, median 20 days (range, 17–23 days); leukapheresis to infusion, median 35 days (range, 26–74 days)
Monitoring/Proximity/Driving	Monitor daily during the first week and continue monitoring for signs or symptoms of CRS and neurologic toxicity for at least 2 weeks; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Monitor daily for at least 7 days and for signs or symptoms of CRS and neurologic toxicity for 2 weeks; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Monitor daily for at least 7 days after each infusion and continue monitoring for at least 2 weeks after each infusion; remain near a health care facility for at least 2 weeks after each infusion; avoid driving for at least 2 weeks after each infusion
CRS Incidence	Any grade: 77%; Grade ≥3: 48% (Penn grading system)	Any grade: 92%; Grade ≥3: 26% (Lee grading system)	Any grade: 75%; Grade 3: 3%
Median Time to CRS Onset	3 days (range, 1–22 days)	5 days (range, 1–12 days)	8 days (range, 1–23 days)
Median Duration/Resolution of CRS	Resolution: 8 days (range, 1–36 days)	8 days (range, 2–63 days)	Duration: 5 days (range, 1–21 days)
ICANS/Neurotoxicity Incidence	Neurologic events: 71%; Grade ≥3: 22%	Neurologic events, including ICANS: 87%; Grade ≥3: 35%	ICANS: 24%; Grade ≥3: 7%. Overall neurologic toxicities: 64%; Grade ≥3: 12%
Median Time to ICANS/Neurotoxicity Onset	Neurologic events: 6 days (range, 1–301 days)	Neurologic events: 7 days (range, 1–51 days)	ICANS: 8 days after Dose 1 (range, 1–10 days); 6.5 days after Dose 2 (range, 2–22 days). Overall neurologic toxicities: 10 days (range, 1–246 days)

Table 1. CAR T-Cell Therapies in B-Cell Acute Lymphoblastic Leukemia (ALL)

(Continued)

Agent	Tisagenlecleucel (KYMRIAH®)	Brexucabtagene autoleucel (TECARTUS®)	Obecabtagene autoleucel (AUCATZYL®)
Median ICANS/ Neurotoxicity Duration/Resolution	Neurologic events: 7 days	Neurologic events: 15 days (range, 1–397 days)	ICANS: 8.5 days (range, 1–53 days). Overall neurologic toxicities: 13 days (range, 1–904 days)
U.S. Boxed Warnings	CRS; neurological toxicities; secondary hematological malignancies	CRS; neurologic toxicities; secondary hematological malignancies	CRS; neurologic toxicities; secondary hematological malignancies
Common Adverse Events (≥20%; incidence)	CRS 77%; unspecified infection 57%; hypogammaglobulinemia 53%; fever 42%; decreased appetite 38%; viral infections 37%; headache 35%; febrile neutropenia 34%; vomiting/musculoskeletal pain/hemorrhage 32% each; encephalopathy 30%; diarrhea/bacterial infection/hypotension 29% each; nausea/cough 27% each; pain/hypoxia 25% each; tachycardia 24%; fatigue/edema 23% each; acute kidney injury 22%; hypocalcemia 20%	Fever 96%; CRS 92%; hypotension 69%; tachycardia/encephalopathy 63% each; nausea 41%; chills 40%; headache 38%; fatigue 37%; febrile neutropenia 35%; diarrhea/musculoskeletal pain 32% each; hypoxia/rash 31% each; edema/tremor 29% each; unspecified infection 28%; constipation 24%; decreased appetite 22%; vomiting 21%	CRS 75%; unspecified infection 44%; musculoskeletal pain 36%; viral infections ≥20% (exact composite incidence not separately reported); nausea/fever 29% each; bacterial infection/febrile neutropenia/diarrhea 26% each; ICANS 24%; hypotension/pain 23% each; fatigue/headache 22% each; encephalopathy 21%; hemorrhage 20%
Grade ≥3 Adverse Events (≥10%; incidence)	CRS 48%; febrile neutropenia 34%; increased AST 29%; decreased potassium 28%; unspecified infection 27%; viral infection/increased ALT 22% each; decreased phosphate/hypoxia/hypotension 20% each; increased bilirubin 19%; bacterial infection 16%; decreased appetite 15%; acute kidney injury/dyspnea 14% each; fever/hypogammaglobulinemia/increased glucose 13% each; decreased fibrinogen 11%; hemorrhage 10%	Decreased white blood cell count 99%; decreased neutrophil count 97%; decreased lymphocyte count 96%; decreased platelet count 87%; decreased hemoglobin 77%; decreased phosphate 47%; fever 38%; febrile neutropenia 35%; hypotension 33%; increased ALT 31%; encephalopathy 27%; CRS 26%; hypoxia/increased AST 23% each; unspecified infection/increased glucose/decreased calcium 22% each; increased uric acid/increased direct bilirubin/decreased sodium 19% each; decreased potassium 13%; increased bilirubin 10%	Decreased lymphocyte count 90%; decreased white blood cell count 87%; decreased neutrophil count 72%; decreased platelet count 48%; decreased hemoglobin 43%; unspecified infection 31%; febrile neutropenia 26%; increased ferritin 13%; bacterial infection 11%; increased AST 10%
Initial U.S. Approval	2017	2020	2024
Initial U.S. Approval for ALL	2017	2021	2024
Pivotal Trial(s)	ELIANA (CCTLO19B2202)	ZUMA-3	FELIX

Table 2. CAR T-Cell Therapies in Chronic Lymphocytic Leukemia/Small Lymphocytic Lymphoma (CLL/SLL)

Agent		Lisocabtagene maraleucel (BREYANZI®)
Manufacturer		Juno Therapeutics Inc., a Bristol-Myers Squibb Company
Target/Construct		CD19; CD28 transmembrane domain; 4-1BB; CD3ζ; lentiviral vector; defined 1:1 CD8/CD4 components
Indication(s)		Adults with R/R CLL or SLL after ≥2 prior lines of therapy, including a BTK inhibitor and a BCL-2 inhibitor
Route of Administration		IV; CD8 component followed immediately by CD4 component
CAR T-Cell Dose		90–110 × 10 ⁶ CAR-positive viable T cells; defined 1:1 CD8/CD4 composition
Lymphodepleting Chemotherapy		Fludarabine 30 mg/m ² /day + cyclophosphamide 300 mg/m ² /day IV for 3 days
Infusion Timing		2–7 days after lymphodepletion; TRANSCEND CLL 004 administered lisocabtagene maraleucel 2–11 days after lymphodepletion
Manufacturing/Availability Time		Leukapheresis to product availability, median 24 days (range, 19–84 days); leukapheresis to infusion, median 36 days (range, 28–384 days)
Monitoring/Proximity/Driving		Monitor daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks
CRS Incidence		CLL/SLL: 83% (74/89); Grade 3: 9%; no Grade 4–5 CRS
Median Time to CRS Onset		4 days (range, 1–18 days)
Median Duration/Resolution of CRS		6 days (range, 2–37 days); 97% resolved
ICANS/Neurotoxicity Incidence		CAR T-cell-associated neurologic toxicities: 46% (41/89); Grade 3: 20%; one Grade 4 event; no Grade 5 events
Median Time to ICANS/Neurotoxicity Onset		7 days (range, 1–21 days)
Median ICANS/Neurotoxicity Duration/Resolution		7 days (range, 1–83 days); 85% resolved
U.S. Boxed Warnings		CRS; neurologic toxicities; secondary hematological malignancies
Common Adverse Events (≥20%; incidence)		CRS 83%; encephalopathy 44%; musculoskeletal pain 42%; fatigue 40%; nausea 35%; edema/diarrhea 30% each; headache 28%; dyspnea/decreased appetite/fever 27% each; constipation/tremor 24% each; unspecified infection/rash 23% each; tachycardia/dizziness 21% each; cough/delirium 20% each
Grade ≥3 Adverse Events (≥10%; incidence)		Encephalopathy 18%; febrile neutropenia 12%; tumor lysis syndrome 11%; unspecified infection 10%; decreased neutrophil count 94%; decreased lymphocyte count 87%; decreased white blood cell count 85%; decreased platelet count 53%; decreased hemoglobin 49%; decreased phosphate 24%; decreased sodium 18%; decreased calcium 11%
Initial U.S. Approval		2021
Initial U.S. Approval for CLL/SLL		2024
Pivotal Trial(s)		TRANSCEND CLL 004

Table 3. CAR T-Cell Therapies in Follicular Lymphoma (FL)

Agent	Axicabtagene ciloleucel (YESCARTA®)	Tisagenlecleucel (KYMRIAH®)	Lisocabtagene maraleucel (BREYANZI®)
Manufacturer	Kite Pharma, Inc.	Novartis Pharmaceuticals Corporation (distributor)	Juno Therapeutics Inc., a Bristol-Myers Squibb Company
Target/Construct	CD19; CD28; CD3ζ; retroviral vector	CD19; 4-1BB; CD3ζ; lentiviral vector	CD19; CD28 transmembrane domain; 4-1BB; CD3ζ; lentiviral vector; defined 1:1 CD8/CD4 components
Indication(s)	Adults with R/R FL after ≥2 lines of systemic therapy	Adults with R/R FL after ≥2 lines of systemic therapy	Adults with R/R FL after ≥2 lines of systemic therapy
Route of Administration	IV; single infusion	IV; single infusion	IV; CD8 component followed immediately by CD4 component
CAR T-Cell Dose	2 × 10 ⁶ CAR-positive viable T cells/kg; maximum 2 × 10 ⁸ cells	0.6–6.0 × 10 ⁸ CAR-positive viable T cells	90–110 × 10 ⁶ CAR-positive viable T cells; defined 1:1 CD8/CD4 composition
Lymphodepleting Chemotherapy	Cyclophosphamide 500 mg/m ² IV + fludarabine 30 mg/m ² IV on Days –5, –4, and –3	Fludarabine 25 mg/m ² IV daily for 3 days + cyclophosphamide 250 mg/m ² IV daily for 3 days; bendamustine 90 mg/m ² IV daily for 2 days is a labeled alternative in specified circumstances.	Fludarabine 30 mg/m ² /day IV + cyclophosphamide 300 mg/m ² /day IV for 3 days
Infusion Timing	Day 0	2–6 days after lymphodepletion	2–7 days after lymphodepletion
Manufacturing/Availability Time	ZUMA-5 primary efficacy population: leukapheresis to product delivery, median 17 days (range, 13–33 days); leukapheresis to infusion, median 27 days (range, 19–250 days)	About 3–4 weeks from receipt of cells at the manufacturing site to shipment back to the health care provider; time may vary	TRANSCEND FL: leukapheresis to product availability, median 29 days (range, 20–55 days); leukapheresis to infusion, median 50 days (range, 31–313 days)
Monitoring/Proximity/Driving	Monitor at least daily for 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Monitor daily during the first week and continue monitoring for signs or symptoms of CRS and neurologic toxicity for at least 2 weeks; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Monitor daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks
CRS Incidence	ZUMA-5 FL: 78%; Grade ≥3: 6% (Lee grading system)	Any grade: 53%; Grade ≥3: 0% (Lee grading system)	Any grade: 59%; Grade 3: 0.9%
Median Time to CRS Onset	4 days (range, 1–15 days)	4 days (range, 1–14 days)	6 days (range, 1–17 days)
Median Duration/Resolution of CRS	6 days (range, 1–27 days)	4 days (range, 1–13 days)	3 days (range, 1–10 days)
ICANS/Neurotoxicity Incidence	ZUMA-5 FL neurologic events: 56%; Grade ≥3: 15%	Neurologic toxicity: 43%; Grade ≥3: 6%	Neurologic events: 15%; Grade 3: 2%
Median Time to ICANS/Neurotoxicity Onset	7 days (range, 1–177 days)	8 days (range, 1–345 days)	8.5 days (range, 4–16 days)
Median ICANS/Neurotoxicity Duration/Resolution	14 days (range, 1–452 days)	5 days	4.5 days (range, 1–17 days)

Table 3. CAR T-Cell Therapies in Follicular Lymphoma (FL)

(Continued)

Agent	Axicabtagene ciloleucel (YESCARTA®)	Tisagenlecleucel (KYMRIAH®)	Lisocabtagene maraleucel (BREYANZI®)
U.S. Boxed Warnings	CRS; neurologic toxicities; secondary hematological malignancies	CRS; neurological toxicities; secondary hematological malignancies	CRS; neurologic toxicities; secondary hematological malignancies
Common Adverse Events (≥20%; incidence)	Study 3 INHL safety population (N=146; 124 FL, 22 MZL): Fever 85%; CRS 84%; hypotension 51%; encephalopathy/fatigue 49% each; unspecified infection/headache 45% each; tachycardia 44%; febrile neutropenia 41%; nausea/musculoskeletal pain 40% each; tremor 31%; diarrhea/chills 29% each; constipation 28%; decreased appetite 26%; cough 25%; vomiting 24%; hypoxia 23%; arrhythmia 21%; dizziness 20%	CRS 53%; unspecified infection 38%; fatigue 27%; musculoskeletal pain/headache 25% each; diarrhea 24%	CRS 59%; musculoskeletal pain/headache 28% each; fatigue 23%; constipation 21%; fever 20%
Grade ≥3 Adverse Events (≥10%; incidence)	Study 3 INHL safety population (N=146; 124 FL, 22 MZL): Febrile neutropenia 41%; encephalopathy 16%; unspecified infection 14%; decreased lymphocyte count 96%; decreased white blood cell count 94%; decreased neutrophil count 92%; decreased platelet count 35%; decreased hemoglobin 32%; decreased phosphate 25%; decreased sodium 10%; increased glucose 10%; decreased calcium 10%	Febrile neutropenia 13%; unspecified infection 12%; decreased neutrophil count 63%; decreased white blood cell count 40%; decreased platelet count 21%; decreased hemoglobin 20%; decreased lymphocyte count 19%; decreased phosphate 12%	No nonlaboratory Grade ≥3 adverse event reached 10%. Decreased lymphocyte count 94%; decreased neutrophil count 79%; decreased white blood cell count 74%; decreased platelet count 17%
Initial U.S. Approval	2017	2017	2021
Initial U.S. Approval for FL	2021	2022	2024
Pivotal Trial(s)	ZUMA-5	ELARA (CCTLO19E2202)	TRANSCEND FL (JCARO17-FOL-001)

Table 4. CAR T-Cell Therapies in Large B-Cell Lymphoma (LBCL)

Agent	Axicabtagene ciloleucel (YESCARTA®)	Lisocabtagene maraleucel (BREYANZI®)	Tisagenlecleucel (KYMRIA®)
Manufacturer	Kite Pharma, Inc.	Juno Therapeutics Inc., a Bristol-Myers Squibb Company	Novartis Pharmaceuticals Corporation (distributor)
Target/Construct	CD19; CD28; CD3ζ; retroviral vector	CD19; CD28 transmembrane domain; 4-1BB; CD3ζ; lentiviral vector; defined 1:1 CD8/CD4 components	CD19; 4-1BB; CD3ζ; lentiviral vector
Indication(s)	Adults with LBCL refractory to first-line chemoimmunotherapy or relapsing within 12 months; or R/R LBCL after ≥2 lines of systemic therapy, including specified subtypes	Adults with specified LBCL who have refractory disease to first-line chemoimmunotherapy or relapse within 12 months; refractory disease or relapse after first-line therapy and are ineligible for HSCT due to comorbidities or age; or R/R disease after ≥2 lines of systemic therapy	Adults with R/R LBCL after ≥2 lines of systemic therapy, including DLBCL NOS, HGBCL, and DLBCL arising from FL
Route of Administration	IV; single infusion	IV; CD8 component followed immediately by CD4 component	IV; single infusion
CAR T-Cell Dose	2×10^6 CAR-positive viable T cells/kg; maximum 2×10^8 cells	After 1 line: $90\text{--}110 \times 10^6$ CAR-positive viable T cells After ≥2 lines: $50\text{--}110 \times 10^6$ CAR-positive viable T cells	$0.6\text{--}6.0 \times 10^8$ CAR-positive viable T cells
Lymphodepleting Chemotherapy	Cyclophosphamide 500 mg/m^2 + fludarabine 30 mg/m^2 IV daily on Days –5, –4, and –3	Fludarabine $30 \text{ mg/m}^2/\text{day}$ + cyclophosphamide $300 \text{ mg/m}^2/\text{day}$ IV for 3 days	Fludarabine 25 mg/m^2 + cyclophosphamide 250 mg/m^2 IV daily for 3 days; bendamustine 90 mg/m^2 IV daily for 2 days is an alternative under labeled circumstances. Lymphodepletion may be omitted in patients with significant cytopenia.
Infusion Timing	Day 0	2–7 days after lymphodepletion	2–11 days after lymphodepletion
Manufacturing/Availability Time	ZUMA-7: delivery 18 days (range, 13–49 days); infusion 26 days (range, 16–52 days) ZUMA-1: delivery 17 days (range, 14–51 days); infusion 24 days (range, 16–73 days)	TRANSFORM: availability 26 days (range, 19–84 days); infusion 36 days (range, 25–91 days). TRANSCEND NHL 001: availability 24 days (range, 17–51 days); infusion 37 days (range, 27–224 days)	About 3–4 weeks from receipt at the manufacturing site to shipment back to the health care provider
Monitoring/Proximity/Driving	Daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Monitor daily during the first week and continue monitoring for signs or symptoms of CRS and neurologic toxicity for at least 2 weeks; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks

Table 4. CAR T-Cell Therapies in Large B-Cell Lymphoma (LBCL)

(Continued)

Agent	Axicabtagene ciloleucel (YESCARTA®)	Lisocabtagene maraleucel (BREYANZI®)	Tisagenlecleucel (KYMRIAH®)
CRS Incidence	ZUMA-7: 92%; Grade ≥3: 7% ZUMA-1: 94%; Grade ≥3: 13%	TRANSFORM: 49%; Grade 3: 1%; no Grade 4–5 PILOT: 38%; Grade 3: 2%; no Grade 4–5 TRANSCEND NHL 001: 42%; Grade ≥3: 2%; no Grade 5	74%; Grade ≥3: 23% (Penn grading system)
Median Time to CRS Onset	ZUMA-7: 3 days (range, 1–10 days) ZUMA-1: 2 days (range, 1–12 days)	TRANSFORM: 5 days (range, 1–63 days) PILOT: 4 days (range, 1–12 days)	3 days (range, 1–51 days)
Median Duration/Resolution of CRS	ZUMA-7: 7 days (range, 2–43 days) ZUMA-1: 7 days (range, 2–58 days)	TRANSFORM: 4 days (range, 1–16 days) PILOT: 4 days (range, 1–12 days) TRANSCEND NHL 001: 5 days (range, 1–17 days)	7 days (range, 2–30 days)
ICANS/Neurotoxicity Incidence	ZUMA-7: neurologic toxicity 74%; Grade ≥3: 25% ZUMA-1: neurologic toxicity 87%; Grade ≥3: 31%	TRANSFORM: neurologic events 11%; Grade 3: 4% PILOT: investigator-defined neurologic events 31%; Grade 3: 5% TRANSCEND NHL 001: neurologic events 30%; Grade ≥3: 10%; no Grade 5 events	Neurologic toxicity 60%; Grade ≥3: 19%
Median Time to ICANS/Neurotoxicity Onset	ZUMA-7: 5 days (range, 1–133 days) ZUMA-1: 4 days (range, 1–43 days)	TRANSFORM: neurologic events 11 days (range, 7–17 days) PILOT (FDA-adjudicated broad neurologic toxicity; definition differs from investigator-defined neurologic events above): 7 days (range, 1–63 days) TRANSCEND NHL 001: neurologic events 9 days (range, 1–66 days)	5 days (range, 1–368 days)
Median ICANS/Neurotoxicity Duration/Resolution	ZUMA-7: 15 days ZUMA-1: 17 days	TRANSFORM: resolution 4.5 days (range, 1–30 days) PILOT (FDA-adjudicated broad neurologic toxicity): resolution 6 days (range, 1–89 days) TRANSCEND NHL 001: resolution 11 days (range, 1–86 days)	17 days
U.S. Boxed Warnings	CRS; neurologic toxicities; secondary hematological malignancies	CRS; neurologic toxicities; secondary hematological malignancies	CRS; neurological toxicities; secondary hematological malignancies

Table 4. CAR T-Cell Therapies in Large B-Cell Lymphoma (LBCL)

(Continued)

Agent	Axicabtagene ciloleucel (YESCARTA®)	Lisocabtagene maraleucel (BREYANZI®)	Tisagenlecleucel (KYMRIAH®)
Common Adverse Events (≥20%; incidence)	ZUMA-7: fever 93%; CRS 92%; fatigue 52%; hypotension 47%; encephalopathy 46%; tachycardia 43%; diarrhea 42%; headache 41%; nausea/musculoskeletal pain 40% each; febrile neutropenia 31%; chills 28%; unspecified infection/tremor 25% each; edema 23%; hypoxia 21%; abdominal pain/constipation/vomiting 20% each ZUMA-1: CRS 94%; fever 86%; tachycardia/hypotension/encephalopathy 57% each; fatigue 46%; headache 45%; decreased appetite 44%; chills 40%; diarrhea 38%; nausea/febrile neutropenia 34% each; hypoxia 32%; tremor 31%; cough 30%; unspecified infection/vomiting 26% each; constipation 23%; arrhythmia 23%; dizziness 21%	TRANSFORM: fever 55%; CRS 49%; musculoskeletal pain 36%; headache 34%; fatigue 28%; nausea 24%; constipation/dizziness 20% each PILOT: fatigue 44%; CRS 39%; fever 38%; nausea 25%; encephalopathy/hypotension/musculoskeletal pain 23% each; edema 20% TRANSCEND NHL 001: fatigue 48%; CRS 46%; musculoskeletal pain 37%; nausea 33%; headache 30%; unspecified infection/encephalopathy 29% each; decreased appetite 28%; diarrhea/hypotension 26% each; tachycardia 25%; dizziness 24%; cough/constipation 23% each; abdominal pain/vomiting/edema 21% each	CRS 74%; unspecified infection 48%; fever 35%; diarrhea 31%; nausea 29%; fatigue/edema 27% each; hypotension 25%; hemorrhage 22%; dyspnea/headache 21% each
Grade ≥3 Adverse Events (≥10%; incidence)	ZUMA-7: febrile neutropenia 31%; encephalopathy 18%; hypotension 11%; decreased white blood cell count 95%; decreased neutrophil count/decreased lymphocyte count 94% each; decreased hemoglobin 40%; decreased platelet count 26%; decreased sodium 12%; increased glucose 11% ZUMA-1: febrile neutropenia 31%; encephalopathy 29%; fever/unspecified infection 16% each; hypotension 15%; CRS 13%; hypoxia 11%; decreased lymphocyte count/decreased white blood cell count 96% each; decreased neutrophil count 92%; decreased hemoglobin 60%; decreased platelet count 56%; decreased phosphate 52%; decreased sodium/decreased albumin 19% each; increased direct bilirubin 14%; increased uric acid 13%; decreased potassium 11%	TRANSFORM: febrile neutropenia 10%; decreased lymphocyte count 98%; decreased neutrophil count 89%; decreased platelet count 48%; decreased hemoglobin 32% PILOT: decreased lymphocyte count 97%; decreased neutrophil count 80%; decreased hemoglobin 30%; decreased platelet count 26%. TRANSCEND NHL 001: unspecified infection 16%; decreased lymphocyte count 95%; decreased neutrophil count 88%; decreased platelet count 41%; decreased hemoglobin 32%; decreased phosphate 16%; decreased fibrinogen 14%	Unspecified infection 26%; CRS 23%; febrile neutropenia 17%; encephalopathy 11%; decreased lymphocyte count 95%; decreased neutrophil count 82%; decreased white blood cell count 78%; decreased hemoglobin 59%; decreased platelet count 56%; decreased phosphate 24%; decreased potassium 13%
Initial U.S. Approval	2017	2021	2017
Initial U.S. Approval for LBCL	2017	2021	2018
Pivotal Trial(s)	ZUMA-7; ZUMA-1	TRANSFORM; PILOT; TRANSCEND NHL 001	JULIET (CCTL019C2201)

Table 5. CAR T-Cell Therapies in Mantle Cell Lymphoma (MCL)

Agent	Brexucabtagene autoleucel (TECARTUS®)	Lisocabtagene maraleucel (BREYANZI®)
Manufacturer	Kite Pharma, Inc.	Juno Therapeutics Inc., a Bristol-Myers Squibb Company
Target/Construct	CD19; CD28; CD3ζ; retroviral vector	CD19; CD28 transmembrane domain; 4-1BB; CD3ζ; lentiviral vector; defined 1:1 CD8/CD4 components
Indication(s)	Adults with relapsed or refractory MCL	Adults with R/R MCL after ≥2 lines of systemic therapy, including a BTK inhibitor
Route of Administration	IV; single infusion	IV; CD8 component followed immediately by CD4 component
CAR T-Cell Dose	2×10^6 CAR-positive viable T cells/kg; maximum 2×10^8 cells	$90\text{--}110 \times 10^6$ CAR-positive viable T cells; defined 1:1 CD8/CD4 composition
Lymphodepleting Chemotherapy	Cyclophosphamide 500 mg/m ² + fludarabine 30 mg/m ² IV on Days –5, –4, and –3	Fludarabine 30 mg/m ² /day + cyclophosphamide 300 mg/m ² /day IV for 3 days
Infusion Timing	Day 0	2–7 days after lymphodepletion
Manufacturing/Availability Time	ZUMA-2: leukapheresis to product delivery, median 15 days (range, 11–28 days); leukapheresis to infusion, median 27 days (range, 19–63 days)	TRANSCEND NHL 001 MCL: leukapheresis to product availability, median 24 days (range, 17–80 days); leukapheresis to infusion, median 36 days (range, 28–489 days)
Monitoring/Proximity/Driving	Monitor daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks	Monitor daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks
CRS Incidence	93%; Grade ≥3: 12% (Lee grading system)	61%; Grade ≥3: 1.1%; one Grade 4 event and no Grade 3 or 5 CRS
Median Time to CRS Onset	4 days (range, 1–13 days)	4 days (range, 1–10 days)
Median Duration/Resolution of CRS	7 days (range, 1–50 days)	4 days (range, 1–14 days)
ICANS/Neurotoxicity Incidence	Neurologic events: 80%; Grade ≥3: 33%	Neurologic events: 31%; Grade ≥3: 9%; no Grade 5 events
Median Time to ICANS/Neurotoxicity Onset	6 days (range, 1–32 days)	8 days (range, 1–25 days)
Median ICANS/Neurotoxicity Duration/Resolution	19 days (range, 1–828 days)	5 days (range, 1–45 days)
U.S. Boxed Warnings	CRS; neurologic toxicities; secondary hematological malignancies	CRS; neurologic toxicities; secondary hematological malignancies
Common Adverse Events (≥20%; incidence)	Study 1, Cohorts 1–2: Fever 94%; CRS 91%; hypotension 57%; encephalopathy 51%; fatigue 48%; tachycardia 45%; unspecified infection 43%; chills 41%; hypoxia 40%; tremor/cough 38% each; musculoskeletal pain 37%; nausea/edema/headache 35% each; constipation 29%; diarrhea 28%; decreased appetite 26%; dyspnea 24%; rash 22%; insomnia/pleural effusion 21% each; aphasia 20%	CRS 61%; fatigue 39%; musculoskeletal pain 38%; encephalopathy 30%; edema 25%; headache 23%; decreased appetite 21%

Table 5. CAR T-Cell Therapies in Mantle Cell Lymphoma (MCL)

(Continued)

Agent	Brexucabtagene autoleucel (TECARTUS®)	Lisocabtagene maraleucel (BREYANZI®)
Grade ≥3 Adverse Events (≥10%; incidence)	Study 1, Cohorts 1–2: Hypotension 27%; encephalopathy/unspecified infection 24% each; hypoxia 20%; CRS 18%; fever 15%; hypertension 11%; decreased white blood cell count 95%; decreased neutrophil count 95%; decreased lymphocyte count 86%; decreased platelet count 63%; decreased hemoglobin 55%; decreased phosphate 30%; decreased calcium 21%; increased uric acid 17%; decreased sodium 16%; increased AST 15%; increased ALT 15%; decreased potassium 10%	No nonlaboratory Grade ≥3 adverse event reached 10%. Decreased lymphocyte count 89%; decreased neutrophil count 85%; decreased white blood cell count 83%; decreased platelet count 39%; decreased hemoglobin 33%; increased uric acid 10%; decreased sodium 10%
Initial U.S. Approval	2020	2021
Initial U.S. Approval for MCL	2020	2024
Pivotal Trial(s)	ZUMA-2	TRANSCEND NHL 001 MCL cohort

Table 6. CAR T-Cell Therapies in Marginal Zone Lymphoma (MZL)

Agent	Lisocabtagene maraleucel (BREYANZI®)
Manufacturer	Juno Therapeutics Inc., a Bristol-Myers Squibb Company
Target/Construct	CD19; CD28 transmembrane domain; 4-1BB; CD3ζ; lentiviral vector; defined 1:1 CD8/CD4 components
Indication(s)	Adults with R/R MZL after ≥2 prior lines of systemic therapy
Route of Administration	IV; CD8 component followed immediately by CD4 component
CAR T-Cell Dose	90–110 × 10 ⁶ CAR-positive viable T cells; defined 1:1 CD8/CD4 composition
Lymphodepleting Chemotherapy	Fludarabine 30 mg/m ² /day + cyclophosphamide 300 mg/m ² /day IV for 3 days
Infusion Timing	2–7 days after lymphodepletion
Manufacturing/ Availability Time	Leukapheresis to product availability, median 29 days (range, 21–44 days); leukapheresis to infusion, median 50 days (range, 30–121 days)
Monitoring/Proximity/ Driving	Monitor daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks
CRS Incidence	Any grade: 76.1%; Grade 3: 4.5%; no Grade 4–5 CRS
Median Time to CRS Onset	4 days (range, 1–29 days)
Median Duration/ Resolution of CRS	4 days (range, 1–13 days)
ICANS/Neurotoxicity Incidence	Neurologic events: 32.8% (22/67); Grade 3: 4.5%; no Grade 4–5 events
Median Time to ICANS/ Neurotoxicity Onset	8.5 days (range, 2–36 days)
Median ICANS/ Neurotoxicity Duration/ Resolution	9 days (range, 1–90 days)
U.S. Boxed Warnings	CRS; neurologic toxicities; secondary hematological malignancies
Common Adverse Events (≥20%; incidence)	CRS 76%; diarrhea 28%; fatigue 27%; musculoskeletal pain 22%; headache/tremor/encephalopathy 21% each
Grade ≥3 Adverse Events (≥10%; incidence)	Decreased lymphocyte count 99%; decreased neutrophil count 84%; decreased white blood cell count 84%; decreased platelet count 28%; decreased hemoglobin 25%; decreased fibrinogen 10%
Initial U.S. Approval	2021
Initial U.S. Approval for MZL	2025
Pivotal Trial(s)	TRANSCEND FL MZL cohort (JCAR017-FOL-001)

Table 7. CAR T-Cell Therapies in Multiple Myeloma (MM)

Agent	Idecabtagene vicleucel (ABECMA®)	Ciltacabtagene autoleucel (CARVYKT®)
Manufacturer	Celgene Corporation, a Bristol-Myers Squibb Company	Janssen Biotech, Inc.; marketed with Legend Biotech
Target/Construct	BCMA; 4-1BB; CD3ζ; lentiviral vector	BCMA with 2 BCMA-binding domains; 4-1BB; CD3ζ; lentiviral vector
Indication(s)	Adults with R/R MM after ≥2 prior lines of therapy, including an IMiD, a proteasome inhibitor, and an anti-CD38 monoclonal antibody	Adults with R/R MM after ≥1 prior line of therapy, including a proteasome inhibitor and an IMiD, and refractory to lenalidomide
Route of Administration	IV; single infusion	IV; single infusion
CAR T-Cell Dose	300–510 × 10 ⁶ CAR-positive T cells	0.5–1.0 × 10 ⁶ CAR-positive viable T cells/kg; maximum 1 × 10 ⁸ cells
Lymphodepleting Chemotherapy	Cyclophosphamide 300 mg/m ² + fludarabine 30 mg/m ² IV daily for 3 days	Cyclophosphamide 300 mg/m ² + fludarabine 30 mg/m ² IV daily for 3 days
Infusion Timing	2 days after lymphodepletion; may delay up to 7 days for unresolved serious adverse events or active infection/inflammation	2–4 days after completion of lymphodepletion; delay for active infection/inflammation or specified Grade ≥3 nonhematologic toxicity
Manufacturing/Availability Time	KarMMa-3: leukapheresis to product availability, median 35 days (range, 24–102 days) KarMMa: leukapheresis to product availability, median 33 days (range, 26–49 days)	CARTITUDE-4: receipt of apheresis material at manufacturing facility to product release, median 44 days (range, 25–127 days); first apheresis to infusion, median 79 days (range, 45–246 days) CARTITUDE-1: leukapheresis to product availability, median 32 days (range, 27–66 days)
Monitoring/Proximity/Driving	Monitor daily for at least 7 days; remain near a health care facility for at least 1 week; avoid driving for at least 1 week	Monitor daily for at least 7 days; remain near a health care facility for at least 2 weeks; avoid driving for at least 2 weeks
CRS Incidence	KarMMa-3 (FDA-adjudicated): 91%; Grade ≥3: 5% KarMMa (FDA-adjudicated): 85%; Grade ≥3: 9%	CARTITUDE-4: 78%; Grade ≥3: 3% CARTITUDE-1: 95%; Grade 3–4: 4%; Grade 5: 1%
Median Time to CRS Onset	KarMMa-3: 1 day (range, 1–27 days) KarMMa: 1 day (range, 1–23 days)	CARTITUDE-4: 8 days (range, 1–23 days) CARTITUDE-1: 7 days (range, 1–12 days)
Median Duration/Resolution of CRS	KarMMa-3: 4 days (range, 1–56 days) KarMMa: 6.5 days (range, 1–63 days)	CARTITUDE-4: median duration 3 days (range, 1–17 days); 99% resolved CARTITUDE-1: median duration 4 days (range, 1–14 days), excluding 1 patient with a 97-day event
ICANS/Neurotoxicity Incidence	KarMMa-3 (FDA-adjudicated CAR T-cell-associated neurologic toxicity): 46%; Grade ≥3: 5% KarMMa (FDA-adjudicated CAR T-cell-associated neurologic toxicity): 28%; Grade ≥3: 4%	CARTITUDE-4: ICANS 7%; Grade 3: 0.5% CARTITUDE-1: ICANS 23%; Grade 3: 3%
Median Time to ICANS/Neurotoxicity Onset	KarMMa-3: 3 days (range, 1–148 days) KarMMa: 2 days (range, 1–42 days)	CARTITUDE-4 ICANS: 9 days (range, 3–15 days) CARTITUDE-1 ICANS: 8 days (range, 1–28 days)

Table 7. CAR T-Cell Therapies in Multiple Myeloma (MM)

(Continued)

Agent	Idecabtagene vicleucel (ABECMA®)	Ciltacabtagene autoleucel (CARVYKT®)
Median ICANS/Neurotoxicity Duration/Resolution	KarMMa-3: duration 9 days (range, 1–720 days); resolution 5 days (range, 1–245 days) KarMMa: duration 6 days (range, 1–578 days); resolution 5 days (range, 1–61 days)	CARTITUDE-4 ICANS: duration 2 days (range, 1–21 days); median resolution 2 days (range, 1–21 days) CARTITUDE-1 ICANS: median time to resolution 6 days (range, 2–143 days)
U.S. Boxed Warnings	CRS; neurologic toxicities; HLH/MAS; prolonged cytopenia; secondary hematological malignancies	CRS; ICANS and other neurologic toxicities, including parkinsonism and GBS; HLH/MAS; prolonged and recurrent cytopenias; IEC-EC; secondary hematological malignancies
Common Adverse Events (≥20% incidence)	KarMMa-3: pyrexia/CRS 91% each; any infection 56%; febrile neutropenia 51%; hypogammaglobulinemia 48%; musculoskeletal pain/hypotension 36% each; unspecified infection 35%; fatigue 33%; tachycardia 32%; diarrhea 31%; nausea 27%; headache 24%; encephalopathy 22%; dyspnea 21%; edema 20% KarMMa: CRS 85%; unspecified infection 51%; fatigue/musculoskeletal pain 45% each; hypogammaglobulinemia 41%; diarrhea 35%; upper respiratory tract infection 34%; nausea 29%; viral infection 27%; encephalopathy 26%; edema/pyrexia 25% each; cough/headache 23% each; decreased appetite 22%	CARTITUDE-4: hypogammaglobulinemia 94%; pyrexia 79%; CRS 78%; musculoskeletal pain 34%; fatigue 28%; diarrhea 27%; upper respiratory tract infection 25%; viral infection/headache/hypotension 23% each; nausea 20% CARTITUDE-1: pyrexia 96%; CRS 95%; hypogammaglobulinemia 93%; hypotension 51%; musculoskeletal pain 48%; fatigue 47%; unspecified infection 41%; cough 39%; chills/diarrhea 33% each; nausea 31%; encephalopathy 30%; decreased appetite 29%; upper respiratory tract infection 28%; headache/tachycardia 27% each; dizziness/dyspnea/edema/viral infection 23% each; coagulopathy/constipation 22% each; vomiting 20%
Grade ≥3 Adverse Events (≥10% incidence)	KarMMa-3: febrile neutropenia 51%; any infection 16%; decreased lymphocyte count 98%; decreased white blood cell count 96%; decreased neutrophil count 96%; decreased platelet count 59%; decreased hemoglobin 52%; decreased phosphate 45%; increased triglycerides 21%; increased ALT 13%; decreased sodium 11%; increased GGT 10% KarMMa: febrile neutropenia 16%; unspecified infection 15%; general physical health deterioration 10%; decreased neutrophil count 96%; decreased white blood cell count 96%; decreased lymphocyte count 92%; decreased platelet count 63%; decreased hemoglobin 63%; decreased phosphate 45%; decreased sodium 10%; increased aPTT 10%	CARTITUDE-4: no nonlaboratory Grade ≥3 adverse event reached 10%; decreased lymphocyte count 99%; decreased neutrophil count 95%; decreased white blood cell count 94%; decreased platelet count 47%; decreased hemoglobin 34% CARTITUDE-1: unspecified infection 19%; pneumonia 13%; hematologic malignancy/hypotension 10% each; decreased lymphocyte count 99%; decreased neutrophil count 98%; decreased white blood cell count 98%; decreased hemoglobin 72%; decreased platelet count 63%; increased AST 21%
Initial U.S. Approval	2021	2022
Initial U.S. Approval for MM	2021	2022
Pivotal Trial(s)	KarMMa-3 (BB2121-MM-003); KarMMa (BB2121-MM-001)	CARTITUDE-4; CARTITUDE-1

Abbreviations: ALL, acute lymphoblastic leukemia; ALT, alanine aminotransferase; aPTT, activated partial thromboplastin time; AST, aspartate aminotransferase; BCL-2, B-cell lymphoma 2; BCMA, B-cell maturation antigen; BTK, Bruton tyrosine kinase; CAR, chimeric antigen receptor; CI, confidence interval; CLL, chronic lymphocytic leukemia; CRS, cytokine release syndrome; DLBCL, diffuse large B-cell lymphoma; FL, follicular lymphoma; GBS, Guillain-Barré syndrome; GGT, gamma-glutamyl transferase; HGBCL, high-grade B-cell lymphoma; HLH/MAS, hemophagocytic lymphohistiocytosis/macrophage activation syndrome; HSCT, hematopoietic stem cell transplantation; ICANS, immune effector cell-associated neurotoxicity syndrome; IEC-EC, immune effector cell-associated enterocolitis; IMiD, immunomodulatory drug; IQR, interquartile range; IV, intravenous; LBCL, large B-cell lymphoma; MCL, mantle cell lymphoma; MM, multiple myeloma; MZL, marginal zone lymphoma; NHL, non-Hodgkin lymphoma; NOS, not otherwise specified; R/R, relapsed or refractory; SLL, small lymphocytic lymphoma.

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