# The Role of Immunotherapy in the Treatment of Acute Lymphoblastic Leukemia: **First Line**

### **Susana Rives**

Pediatric Hematology.

CAR T- Cell Unit. Hospital Sant Joan de Déu de Barcelona.



# Disclosures

Consulting fees, Advisory	Novartis, Amgen, Servier, JazzPharma, Celgene/Bristol-Meyers,
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# Relapse/Refractory Acute Lymphoblastic Leukemia (r/r ALL)

Prognosis of r/r ALL is poor

- Immunotherapy in chemo-resistant disease has proven clinical benefit
  - Redirecting T-cells against leukemia antigen surface molecules (e.g.CD19)
  - Approved indications in r/r BCP-ALL:

BITEs (CD19-CD3)

-Blinatumomab

### **CD19 CAR T-cells**

- → Tisa-cel: children and YA (<26 yr):
- → ARI-0001-cells (Barcelona academic CAR19 T-cell): adults >25 yr (under hospital exemption)\*
- $\rightarrow$  Brexu-cel (KTE-X19): adults  $\geq$ 18 yr:

# EMA Approved indications of BITEs and CAR T-cells in ALL

### Blinatumomab

### Tisagenlecleucel

### • Adults

- CD19+ Ph neg r/r ALL or MRD <u>></u>0.1%
- CD19+ Ph pos r/r ALL after failure <u>></u>2 TKI
- Children >1 yr of age
  - CD19+ Ph neg r/r ALL after <u>></u>2 lines of therapy
  - CD19+ Ph neg high risk relapse as consolidation treatment
  - NOT yet approved in MRD+ (FDA approved)

- Pediatric and young adults (<26 yr) CD19+ ALL
  - 2nd or greater relapse
  - Relapse after HSCT
  - Refractory/relapse after <u>></u>2 lines of therapy

# **Activity of Blinatumomab in ALL. The present**

Type of ALL	Ph-pos R/R adults	Ph-pos 1 <sup>st</sup> line adults	Ph- R adı	neg /R ults	MRD + adults	Ph-neg R/R children	Ph-neg R/R children	Ph-neg 1 <sup>st</sup> relapse children
Study	Pivotal Phase II ALCANTAR A	Plase II D-ALBA <sup>1</sup>	Confirm Phase II	Phase III TOWER	Phase II BLAST	Phase I/II Study 205	Phase II Exp. access RIALTO	Phase III AALL1331 COG
Patients (N)	45	63	189	271 <sup>2</sup>	116	70	98	105 <sup>2</sup>
CR/CRh/CRi (%)	36	92	43	45	NA	39	60	-
MRD level <0.01%	88	58	82	76	78	54	76	66
OS, median, mo	7.1	NA (94%, 1y)	6.1	7.7	36	7.5	13	NA (79%, 2y)

Slide Courtesy of Prof. Ribera

<sup>1</sup> Dasatinib and blinatumomab; <sup>2</sup> Patients randomized to blinatumomab

# Blinatumomab in pediatric advanced r/r ALL (monotherapy)



#### Stackelberg A et al. J Clin Oncol 2016



ONCOLOGY

GROUP

# Blinatumomab as consolidation in pediatric 1st High Risk Relapse



Brown P et al JAMA 2021 (COG, Ped + YA <30 yr)

Caution:BIASS results from randomization: not from the beginng of the trial

#### A Event-free survival



Locatelli F et al. JAMA 2021 (IntReALL)

# **BLINATUMOMAB** in First Line

### Blinatumomab in first line in ALL (children & adults)

**TABLE 2.** Ongoing Clinical Trials With Front-Line Blinatumomab in Pediatric and Adult ALL

Short Title	Primary End Points	Study Design, Sponsor, and NCT Identifier
Blinatumomab added to prephase and consolidation therapy in BCP-ALL	MRD negativity	Phase II, HOVON, NCT03541083
Blinatumomab in consolidation and maintenance in patients with high-risk BCP-ALL	Disease-free survival at 3 years	Phase II, GRAAL, NCT03709719
Combination chemotherapy with or without blinatumomab for newly diagnosed BCR-ABL–negative BCP-ALL	Overall survival	Phase III, ECOG, NCT02003222
Blinatumomab in sequential combination with hyper-CVAD as front-line therapy for BCP-ALL	Relapse-free survival at 2 years	Phase II, MDACC, NCT02877303
Blinatumomab with sequential dose-reduced chemotherapy in older patients with BCR-ABL–negative BCP-ALL	Hematologic and MRD response after induction therapy	Phase II, EWALL, NCT03480438
Blinatumomab during consolidation to reduce mrd in patients with high-risk BCP-ALL	Reduction of MRD determined by MFC	Phase II, PETHEMA, NCT03523429
Front-line sequential treatment with dasatinib and blinatumomab in ph+ BCP-ALL	MRD negativity	Phase II, GIMEMA, NCT02744768
Blinatumomab with sequential chemotherapy to improve MRD response and survival in BCR-ABL negative BCP-ALL	MRD negativity	Phase II, GIMEMA, NCT03367299
Blinatumomab in combination with chemotherapy in pediatric and AYA patients with BCP-ALL	Disease-free survival up to 5 years	Phase III, NCI-COG, NCT03914625
Blinatumomab in adult patients with MRD of BCP-ALL (blast successor trial)	MRD negativity after one cycle	Phase II, GMALL, NCT03109093
Combination of blinatumomab and ponatinib in Ph+ BCP-ALL	MRD negativity	Phase II, MDACC, NCT03263572

### Blinatumomab in first line in ALL (children & adults)

TABLE 2. Ongoing Clinical Trials With Front-Line Blinatumomab in Pediatric and Adult ALL

Short Title	Primary End Points	Study Design, Sponsor, and NCT Identifier
Blinatumoma	b added to prephase and consolidation therapy in BCP-ALL MRD negativity	Phase II, HOVON, NCT03541083
Blinatumoma BCP-ALL	1st line blinetumemen in edult ALL	II, GRAAL, 03709719
Combination BCR-ABL-	Randomized trial Chemo vs Chemo + blina (ECOG, NCT02003222	2) III, ECOG, 02003222
Blinatumoma therapy for	Chemo + Blina as consolidation /maintenance Chemo + Blina to reduce MRD (PETHEMA , NCT03523429)	II, MDACC, 02877303
Blinatumoma with BCR	TKI (daca) + Blipa in Dh. ALL (D. ALBA CINAENAA)	II, EWALL, 03480438
Blinatumoma BCP-ALL	TKI (dasa) + Blina in Ph+ ALL (D-ALBA GIMEWA) TKI (pona) + Blina in Ph+ ALL (MDACC)	, PETHEMA, 03523429
Front-line sec ALL	Ino + blina in elderly ALL (Alliance, NCT03739814)	I, GIMEMA, 02744768
Blinatumoma survival in	Reduced intensity chemo + blina (+dasa if Ph+) (elderly)	I, GIMEMA, 03367299
Blinatumoma patients wi	th BCP-ALL	II, NCI-COG, NCT03914625
Blinatumoma	b in adult patients with MRD of BCP-ALL (blast successor trial) MRD negativity after one cycl	e Phase II, GMALL, NCT03109093
Combination	of blinatumomab and ponatinib in Ph+ BCP-ALL MRD negativity	Phase II, MDACC, NCT03263572

Table 2. Table containing all ongoing clinical trials with blinatumomab for pediatric patients.

	Clinical Trials Identifier	Other Study ID Numbers	Ref. <sup>1</sup>	Title	Age	Status
Ongoing Blinatumomab clinical trials in pediatri	<b>CS</b> NCT01471782	MT103-205 2010-024264-18 (Eudra-CT)	[21]	Clinical Study With Blinatumomab in Pediatric and Adolescent Patients With Relapsed/Refractory B-precursor Acute Lymphoblastic Leukemia	Up to 17 years (child)	completed
	NCT02187354	RIALTO 2014-001700-21 (EudraCT)	[25]	Expanded Access Protocol-Blinatumomab in Pediatric & Adolescent Subjects with Relapsed/Refractory B-precursor ALL (RIALTO)	Up to 17 years (child)	completed
1st line:	NCT02783651	20150253		A Study of Patients with Ph- Chromosome-negative Relapsed or Refractory Acute Lymphoblastic Leukemia in the US	Child, adult	completed
IR/HR: Chemo+ blina (as consolidation or as bridge to HSCT) Infants (Interfant chemo backbone + blinatumomab)	NCT02879695	NCI-2016-01300 (CTRP)		Blinatumomab and Nivolumab With or Without Ipilimumab in Treating Patients With Poor-Risk Relapsed or Refractory CD19+ Precursor B-Lymphoblastic Leukemia Phone 3 Trial of Blinatumemab us	16 years and older	recruiting
Down Syndrome (instead of consolidation chemo blocks)	NCT02393859	2014-002476-92 (EudraCT)	[39]	Standard Chemotherapy in Pediatric Subjects With High-Risk (HR) First Relapse B-precursor Acute Lymphoblastic Leukemia (ALL)	Up to 17 years (child)	active, not recruiting
<ul> <li>1st relapse</li> <li>Blina + chemo (as consolidation or as bridge to HSCT)</li> </ul>	NCT04546399	NCI-2020-06813 (CTRP)		A Study to Compare Blinatumomab Alone to Blinatumomab With Nivolumab in Patients Diagnosed With First Relapse B-Cell Acute Lymphoblastic Leukemia (B-ALL)	1 to 31 years (child, adult) Including Down syndrome patients	recruiting
<ul> <li>Blina + checkpoint inhibitors in R/R ALL</li> </ul>	NCT03914625	NCI-2019-02187 (CTRP)		A Study to Investigate Blinatumomab in Combination With Chemotherapy in Patients With Newly Diagnosed B-Lymphoblastic Leukemia	1 to 31 years (child, adult) Including Down syndrome patients	recruiting
After HSCT Blina + DLI (prophylactic or preemptive)	NCT02101853	NCI-2014-00631 (CTRP) COG-AALL1331	[38]	Blinatumomab in Treating Younger Patients With Relapsed B-cell Acute Lymphoblastic Leukemia	1 to 31 years (child, adult)	Active, not recruiting
	NCT02877303	NCI-2017-00596 (CTRP)		Blinatumomab and Combination Chemotherapy as Frontline Therapy in Treating Patients With B Acute Lymphoblastic Leukemia	14 years and older	recruiting
Citation: Queudeville, M.; Ebinger, M. Blinatumomab in Pediatric A cute Lymphoblastic Leukemia—From	NCT02790515	REF2HCT NCI-2016-00812 (CTRP)		Provision of TCRγδ T Cells and Memory T Cells Plus Selected Use of Blinatumomab in Naïve T-cell Depleted Haploidentical Donor Hematopoietic Cell Transplantation for Hematologic Malignancies Relapsed or Refractory Despite Prior Transplantation	Up to 21 years	recruiting
Salvage to First Line Therapy (A Systematic Review). J. Clin. Med. 2021, 10, 2544. https://doi.org/ 10.3390/jcm10122544	NCT03849651	HAP2HCT		TCRαβ-depleted Progenitor Cell Graft With Additional Memory T-cell DLI, Plus Selected Use of Blinatumomab, in Naive T-cell Depleted Haploidentical Donor Hematopoietc Cell Transplantation for Hematologic Malignancies	Up to 21 years	recruiting

# INOTUZUMAB

### **EMA Approved indications of INOTUZUMAB in ALL**

**ADULTS** 

### CHILDREN

AS MONOTHERAPY

• CD22+ Ph neg r/r ALL

 CD22+ Ph+ r/r ALL after failure <u>></u>1 TKI

## Not yet approved

Phase I/II clinical trials in R/R ALL ongoing(results similar to adults)Phase III clinical trials in 1st line

### **Activity of inotuzumab in ALL**

Study	Phase II, single dose R/R	Phase II, weekly dose R/R	Phase II, weekly dose, multicenter R/R	Phase III INO-VATE R/R	InO + mini HyperCVD, R/ R	Phase II R/ R Children Compassio nate use	InO + mini HyperCVD Frontline elderly
Patients (N)	49	41	35	109	70	51	52
Dose /schedule	1.8 mg/m² D1 q 3–4 wks	0.8 mg/m <sup>2</sup> D1 0.5 mg/m <sup>2</sup> D8, 15	0.8 mg/m <sup>2</sup> D1 0.5 mg/m <sup>2</sup> D8, 15	0.8 mg/m² D1 0.5 mg/m² D8, 15	1.3–1.8 mg/ m², cycle 1 1.0–1.3 mg/ m², cycles 2–4		1.3–1.8 mg/ m <sup>2</sup> , cycle 1 1.0–1.3 mg/ m <sup>2</sup> , cycles 2–4
ORR, %	57	59	68	88	77	67	87
CR, %	18	20	31	36	59	36	80
MRD negativity*, %	68	71	84	78	81	71	96
OS, median, mo	5	7.3	7.4	7.7	11	6	Not reached

\*Among responders.

Adapted from Kantarjian H, Jabbour E. Am Soc Clin Oncol Educ Book 2018;574–78.

Slide Courtesy of Prof. Ribera

# **CAR T-CELLS**

# CAR T-cells FDA approved in ALL

Slide courtesy of JM Ribera

	Brex	Tisa-cel	
FDA Approval	Octobe	2017	
Approved indication	Adults R/R BCP ALL (review) BCP children & AYA (≤21 yr) (devel)		BCP children & AYA (≤25 yr)
Clinical Trial	ZUMA-3	ZUMA-4	ELIANA
N Pts (ITT)	71	31	97
N (evaluable)	55	24	79
CR/CRi (%)	71 (evaluable)	67 (evaluable)	82.3 (evaluable)
RFS/PFS/EFS	mRFS 11.6 m (evaluable)	mRFS NR (evaluable)	18m RFS: 66% (evaluable)
OS	mOS 18.2 m (evaluable)	2yr OS 87.5% (evaluable)	18m OS: 70% (evaluable)
G ≥3 AE (%)	95	100	-
G ≥3 CRS, %	24	22	48
G≥ 3 neurol ev.	25	11	13

# CAR T-cells in 1st line pediatric & YA ALL Cassiopeia trial (EUDRACT 2017-002116-14)



# HOW TO INTEGRATE IMMUNOTHERAPY APPROACHES IN 1ST LINE ALL

### ALL together (A2G)

Molecularly and Immunologically Targeted Therapy in pB ALL

Risk group	Therapeutic question
VLR	Standard chemotherapy RANDOMIZED DE-ESCALATION
IR-low	<ul> <li>→Less (or no) anthracyclines</li> <li>→No pulses</li> </ul>
IR-high	Inotuzumab
VHR	CAR-T 1st line (instead of transplant)
ABL-class fusions	Imatinib since day +15 induction
Down Syndrome	Blinatumomab (Instead of HR blocks)

CAR-T 1st line: clinical trial CASSIOPEIA (COG AALL1721 + ALL-TOGETHER VHR + SEHOP-PETHEMA 2013 VHR) Tisagenlecleucel patients NCI-HR (age <a>10</a> yr and/or leukocytes <a>50 x 10<sup>9</sup>/L & MRD end of consolidation <a>0,01%)

### COG B-ALL : Molecularly and Immunologically Targeted Therapy

Risk group	DFS 5 years	Therapeutic question
SR-favorable	>95%	
HR-favorable	>94%	Standard chemotherapy
SR-average & HR	≈85%	Blinatumomab
HR	≈80%	Inotuzumab
VHR	<50%	CAR-T 1st line (instead of transplant)
Ph and Ph like	60-85%	Molecularly targeted chemotherapy

CAR-T 1st line: clinical trial CASSIOPEIA (COG AALL1721 + ALL-TOGETHER VHR + SEHOP-PETHEMA 2013 VHR + other groups) Tisagenlecleucel patients NCI-HR (age  $\geq$ 10 yr and/or leukocytes >50 x 10<sup>9</sup>/L & MRD end of consolidation >0,01%)

Slide adapted from M. Loh, personal comunication I-BFM Prague, 2019

### How to integrate immunotherapy approaches in 1st line ALL?

- Chemotherapy + immunotherapy as consolidation
  - to improve outcomes in HR patients
  - to reduce toxicity (substitution of intensive chemotherapy blocks or even HSCT)
- Reduced intensity chemotherapy + immunotherapy +/- TKI
- Chemotherapy free: eg. blina + TKIs

# Still many unanswered questions

- How to best use immunotherapy (in front-line and R/R setting)
  - Predictive factors for immunotherapy response
  - Can blinatumomab in MRD+ patients avoid HSCT
  - When to bridge to HSCT after CAR-T?
- How to combine immunotherapy
  - Should we avoid blinatumomab /inotuzumab prior to CAR T-cells
  - Do TKIs after CAR T-cells inhibit CAR T-cell function?

# Impact of prior blinatumomab exposure on survival after CAR T-cell

Fig. 2 Outcome according to prior blinatumomab exposure. Kaplan–Meier curves for A event-free survival and B survival according to prior blinatumomab. Blin blinatumomab.



Dourthe ME et al. *Leukemia*. 2021; doi:10.1038/s41375-021-01281-7.

# Blinatumomab pre CAR T-cells

n=422 patients (multicentric sutdy) Different CAR19 constructs n=75 prior blina

#### Figure 1B. Event Free Survival



Taraseviciute A, *Blood* (2020) 136 (Suppl 1): 13–14. DOI: <u>https://doi.org/10.1182/blood-2020-139260</u>

	Table 1.	All (n=420)	Blina (n=75)	No Blina (n=345)	р
	Demographics				
	Median age at dx, years (IQR)	7.1 (3.2-13.8)	6.8 (2.0-12.2)	7.6 (3.6-14.0)	0.03
	Median age at CAR infusion, years (IQR)	12.4 (7-17.1)	10.0 (5.9-18)	12.8 (7.8-17)	0.12
IIS	Median age at blina infusion, years (IQR)	N/A	7.6 (4.0-16.0)	N/A	
					0.40
					0.03 0.49
Prior to CAR T		No blina	i blina		
Response to C	AR T				0.79
MRD neg CR:		90%	80%		1
		5070			0.25
Refractory to	CAR T	18%	7%	<i>p</i> =0.0052	0.49
					0.07
Cumulual					0.07
Survival					
Median EFS		6 mo	23 mo	<i>p</i> =0.0034	0.07
	CD19 negative	0 (0%)	0 (0%)	0 (0%)	
	Unknown	12 (2.9%)	6 (8%)	6 (1.7%)	
	Post-CAR Response*				
	Complete Remission, n (%)	375 (91.0%)	58 (81.7%)	317 (92.7%)	0.0052
	Non-response, n (%)	37 (10.0%)	13 (18.3%)	24 (7.0%)	0.0002
	MRD neg CR, n (%)	363 (88.1%)	57 (80.2%)	306 (89.7%)	0.04
	Median RFS, (95% CI)	40.2 months (24.9-not est)	20.3 months (5.85-34.4 months)	44.9 months (28.4 months-not est.)	0.027
	6-month RFS, (95% CI)	78.4% (73.8-82.2%)	63.4% (49.6-74.4%)	81.1% (76.3-85.0%)	
	12-month RFS. (95% CI)	67.7% (62.6-72.3%)	57.5% (43.4-69.2%)	69.2% (63.7-74.1%)	
	Median EFS, (95% CI)	20.2 months (13.9-27.3 months)	5.8 months (3.9-20.3 months)	22.6 months (15.8-38.7 months)	0.0034
	6-month EFS, (95% CI)	68.4% (63.8-72.7%)	49.7% (37.8-60.5%)	72.1% (67.1-76.6%)	
	12-month EFS, (95% CI)	57.2% (52.3-61.9%)	46.7% (34.9-57.6%)	59.6% (54.1-64.6%)	
	Median OS, (95% CI)	49.1 months (40.4-not est)	46.3 months (17.9 months-not est)	49.1 months (40.4 months-not est)	0.30
	6-month OS, (95% CI)	84.5% (80.7-87.6%)	75.8% (64.4-84.0%)	86.4% (82.3-89.6%)	
	12-month OS, (95% CI)	76.4% (70.1-78.5%)	67.1 (55.0-76.6%)	76.2 (71.7-80.4%)	
	*Only 344 patients evaluated t	for CNS status; ^Only 4	12 patients were evaluate: #CD19 expression	able for response post-CA	R T-cells,

# Still many unanswered questions

- How to best use immunotherapy (in front-line and R/R setting)
  - Predictive factors for immunotherapy response
  - Can blinatumomab in MRD+ patients avoid HSCT
  - When to bridge to HSCT after CAR-T?
- How to combine immunotherapy /sequence
  - Should we avoid blinatumomab /inotuzumab prior to CAR T-cells
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