

# New Therapies for Acute Myeloid Leukemia

Nandita Khera MD MPH
Mayo Clinic Arizona
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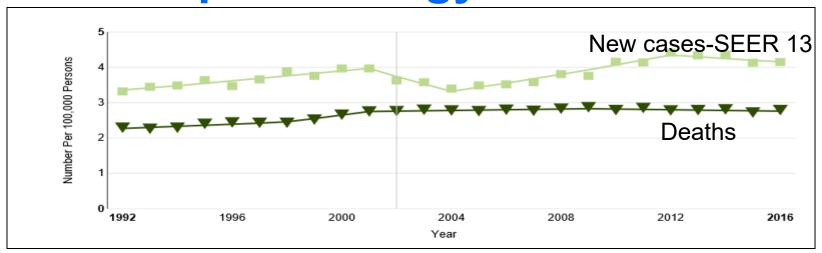


### **Learning Objectives**

- Identify risk stratification schema for AML to guide t/t selection and prognosis
  - Diagnostic workup
- Describe management for specific AML types
  - FLT3 AML
  - Elderly/ Poor risk AML
  - Secondary/ therapy related AML/ AML with targetable mutations
  - Good risk: Core binding factor AML
- Summarize the treatment for AML in 2021



### **Epidemiology of AML**



At a Glance	
Estimated New Cases in 2019 (% of all cancers)	21,450 (1.2%)
Median age at diagnosis	68 years
Estimated Deaths in 2019 (% of all cancer deaths)	10,920 (1.8%)
Percent Surviving 5 Years (2009 to 2016)	28%



#### Risk Stratification for AML

#### **Favourable**

- t(8;21)(q22;q22.1); RUNX1-RUNX1T1
- inv(16)(p13.1q22) or t(16;16)(p13.1;q22); CBFB-MYH11
- NPM1mut without FLT3-ITD or with FLT3-ITDlow
- Biallelic mutated CEBPA

#### Intermediate

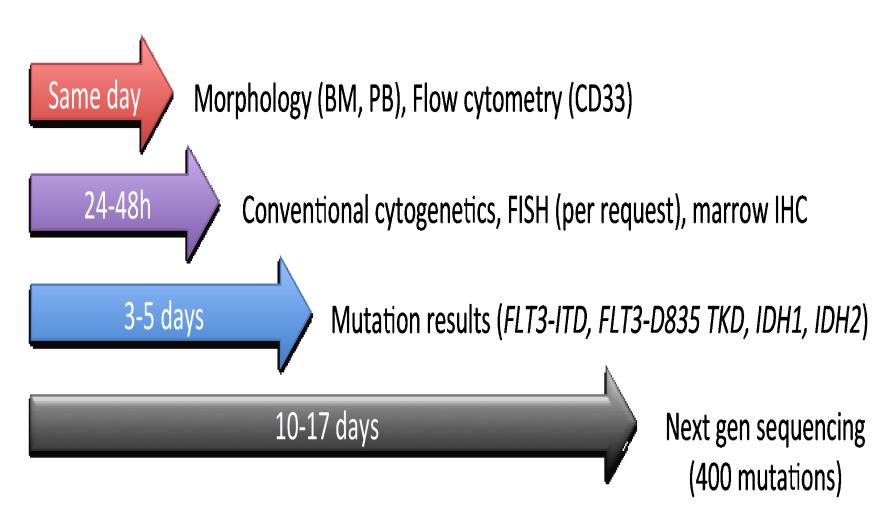
- NPM1mut and FLT3-ITDhigh
- NPM1wt without FLT3-ITD or with FLT3-ITD<sup>low</sup> (without adverse-risk genetic lesions)
- t(9;21)(q21.3;q23.3); MLLT3-KMT2A
- · Cytogenetic abnormalities not classified as favourable or adverse

#### **Adverse**

- t(6:9)(p23:q34.1); DEK-NUP214
- t(v;11q23.3); KMT2A rearranged
- t(9;22)(q34.1;q11.2); BCR-ABL1
- inv(3)(q21.3q26.2) or t(3;3)(q21.3;q26.2); GATA2,MECOM(EVI1)
- -5 or del(5q); -7; -17/abn(17p)
- · Complex karyotype, monosomal karyotype
- NPM1wt and FLT3-ITDhigh
- Mutated RUNX1
- Mutated ASXL1
- Mutated TP53



### Diagnostic Workup for AML in 2021





#### The NEW ENGLAND JOURNAL of MEDICINE

#### ORIGINAL ARTICLE

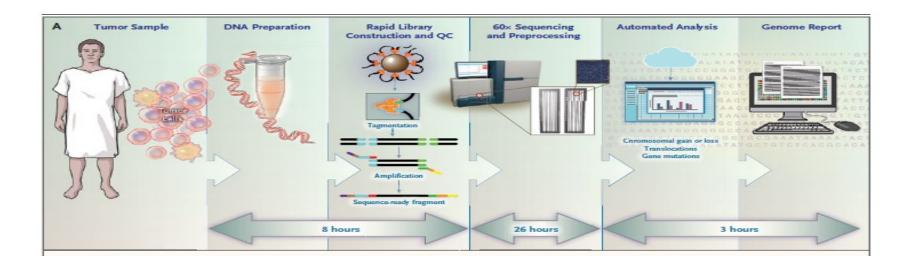
### Genome Sequencing as an Alternative to Cytogenetic Analysis in Myeloid Cancers

N Engl J Med 2021;384:924-35.

DOI: 10.1056/NEJMoa2024534

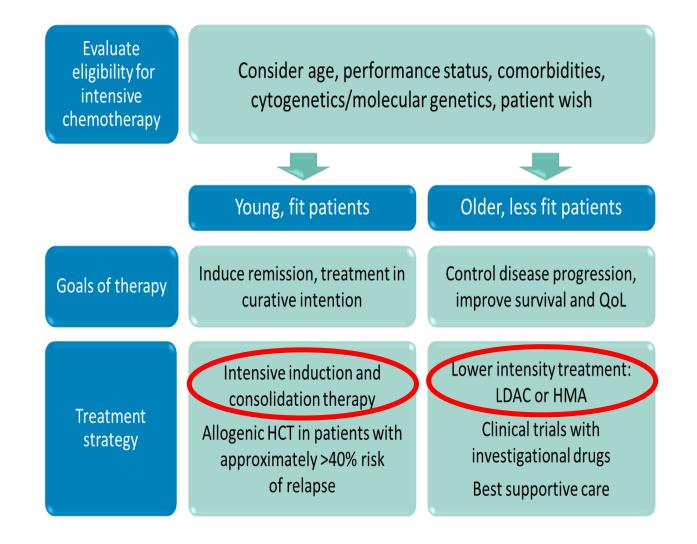


# Workflow and processing time for each step of WGS and Cost



Estimated costs for current tests: \$2000 ( CG and targeted molecular test) Rough cost range for WGS: \$1284-\$ 2523

### Algorithm of AML Therapy (circa 2017)





### Changing paradigm of AML treatment

### Induction treatment

- Cytotoxic chemotherapy
- Hypomethylating agents
- Targeted agents

#### Consolidation

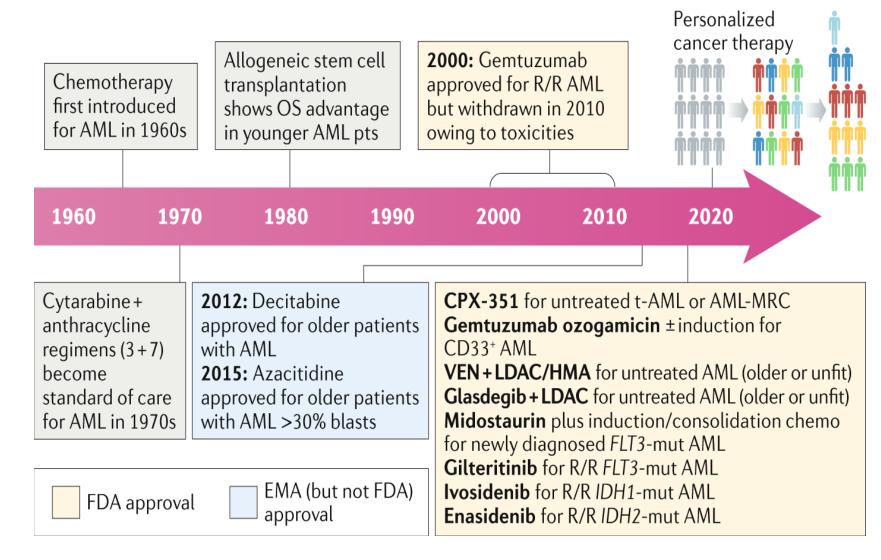
- High dose cytarabine
- Allogeneic HCT

### Maintenance (with or without HCT)

- Targeted agents
- Hypomethylating agents
  - · Iv or Sc Decitabine/ Azacitidine
  - Oral Azacitidine



### Drugs for treatment of AML



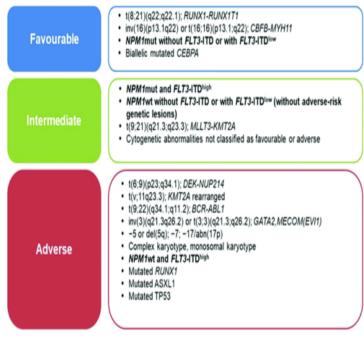


#### Patient case 1

- 60y/M with h/o Crohn's disease found to have a WBC of 43K with Blasts at 15K, Hb of 10.2 and platelets of 41 at annual labs
- BM biopsy showed 99% cellularity with 73% blasts.
  - Cytogenetics and FISH were normal
  - NGS showed FLT3 ITD (allelic ratio 0.3)
- Induction chemo with 7+3 with idarubicin and cytarabine with midostaurin from D8 to D21
  - D21 marrow showed no e/o AML
  - Recovery marrow: hypocellular with 3% blasts; FLT3 +ve



#### **Risk Stratification for AML**



Dohner et al. Blood 2017



### Patient case 1 (contd)-

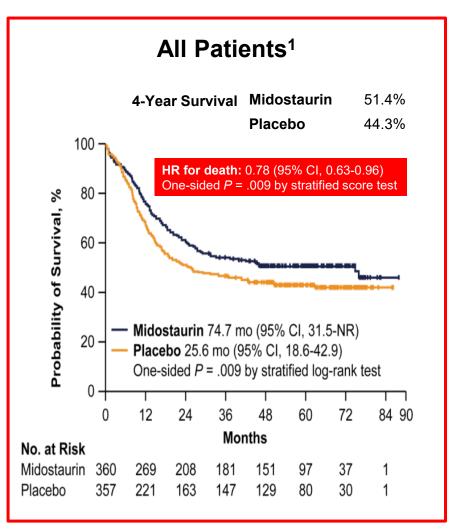
- Received one cycle of consolidation with high dose cytarabine and midostaurin
- Underwent 10/10 Matched Unrelated donor hematopoietic cell transplant
- Enrolled on BMT CTN 1506 study for Gilteritinib maintenance post HCT
- 15 months out from HCT-doing well

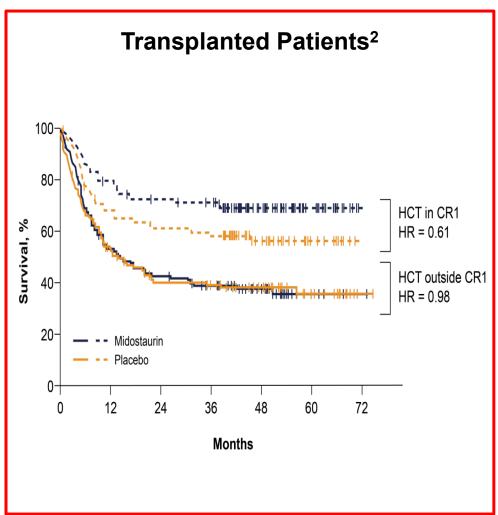


### **FLT 3 POSITIVE AML**

- Newly Diagnosed AML
- Relapsed Refractory AML
- Maintenance post allogeneic HCT

# RATIFY Trial: Midostaurin plus Chemotherapy for AML with a *FLT3* Mutation



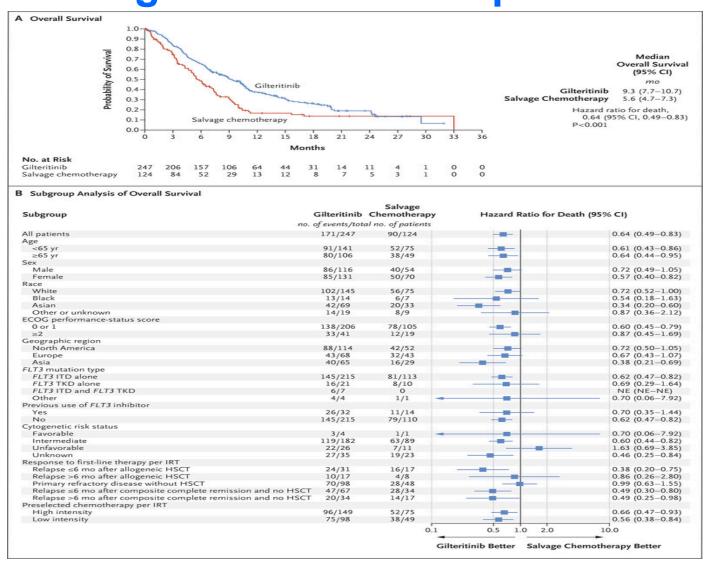




### FLT3 inhibitors in upfront setting

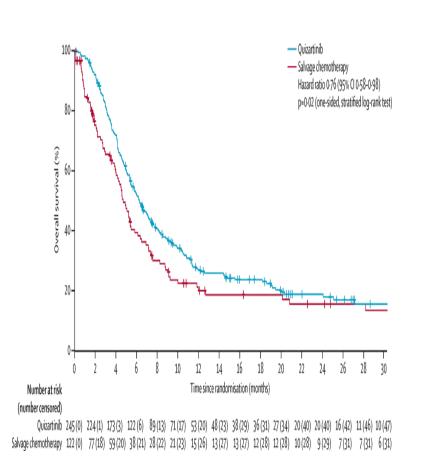
- Phase I study: Gilteritinib plus induction and consolidation chemotherapy
  - well tolerated in patients with newly diagnosed AML
- PrE0905: A Randomized Trial of Gilteritinib vs Midostaurin in FLT3 Mutated Acute Myeloid Leukemia
- QUANTUM-First: Ph III randomized study of 7+3 vs. 7+3 +Quizartinib

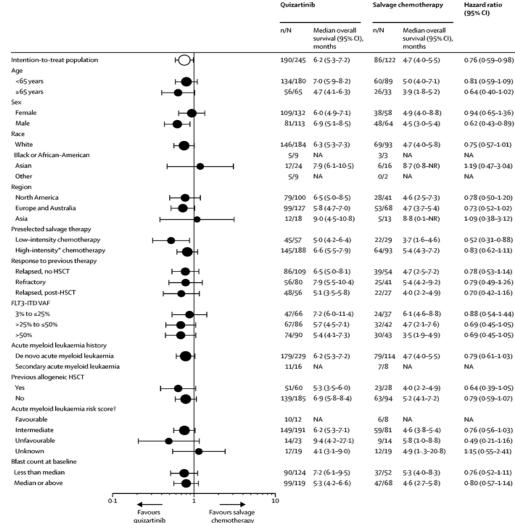
# MAYOCLINIC ADMIRAL Trial: Gilteritinib vs. Salvage Chemo in Relapsed AML



#### MAYO CLINIC

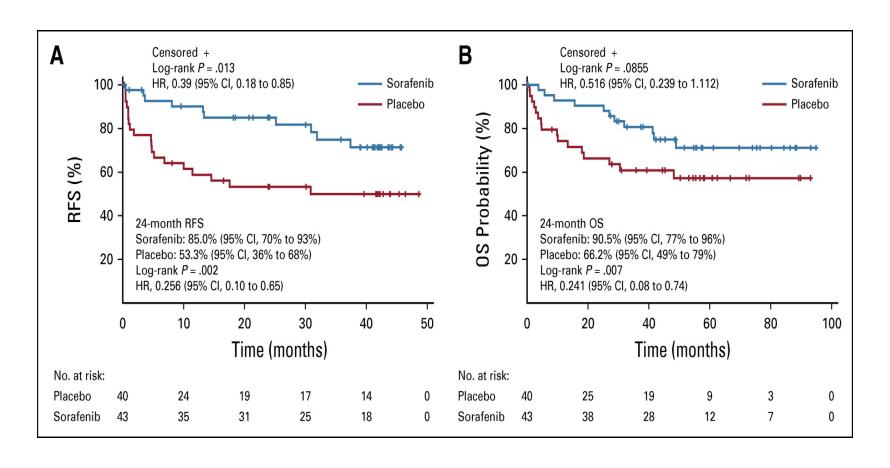
### QuANTUM-R: Quizartinib vs. salvage chemo in relapsed/ refractory AML





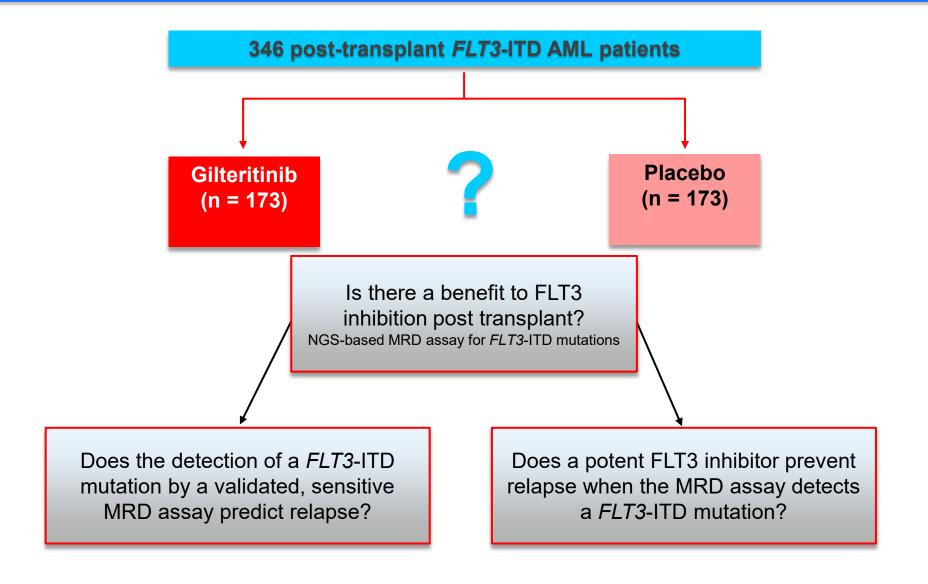


# SORMAIN Trial: Sorafenib Maintenance After Allogeneic HCT for FLT3 AML





#### **BMT-CTN 1506/Morpho Trial**





### Patient case 2

- 73 y/o M with a h/o Atrial fibrillation, HTN, DM II, and GERD diagnosed with AML with 50% blasts
  - Cytogenetics-complex karyotype
  - NGS with p53 and KRAS
- Critically ill at diagnosis-intubated for acute respiratory failure, A Fib with RVR
- Options discussed
  - Supportive care
  - Hypomethylating agents (5 days vs. 10 days)+/- venetoclax
  - Low dose cytarabine+ venetoclax
  - Low dose cytarabine + Glasdegib



### Patient case 2 (contd)-

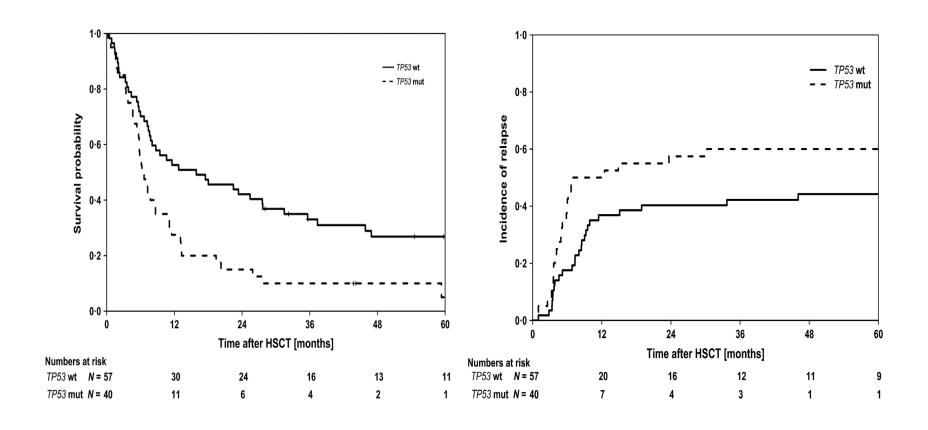
- Started on decitabine; venetoclax ordered
- Multiple complications with sepsis, renal failure requiring dialysis, continued ventilator dependent respiratory failure
- Despite aggressive care, he deteriorated and was made comfort care



# POOR RISK AML (COMPLEX KARYOTYPE/ TP53)/ ELDERLY AML

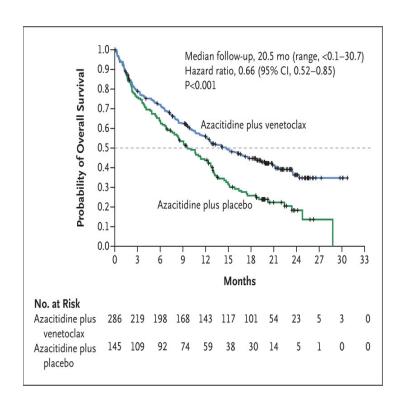


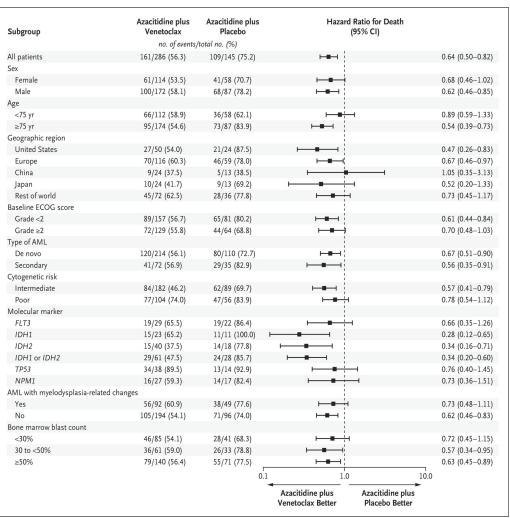
## TP53- The villain in the AML drama!



#### MAYO CLINIC

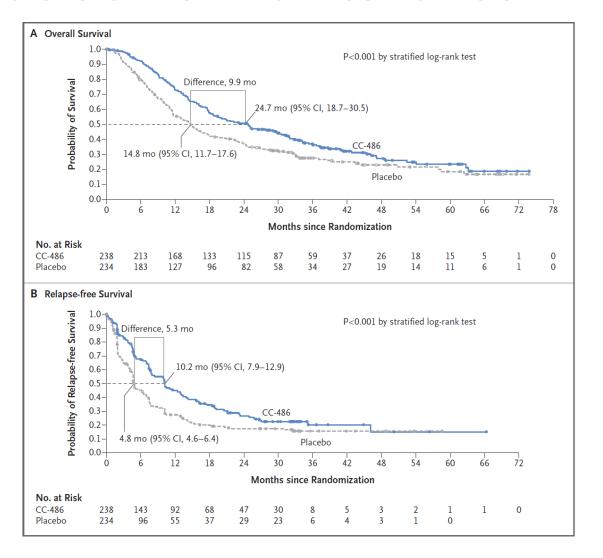
# **VIALE-A: Azacitidine and Venetoclax in Previously Untreated AML**





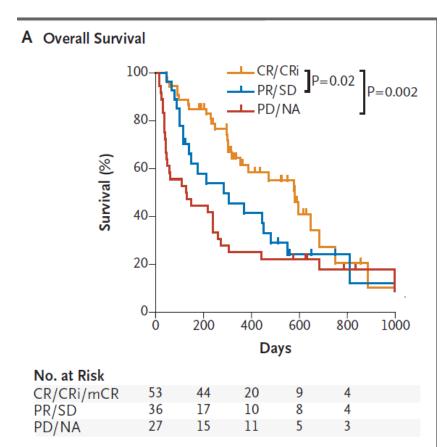


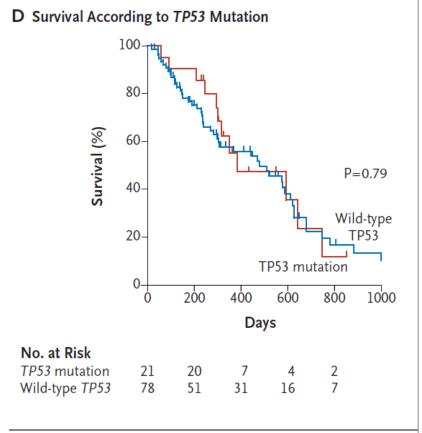
## QUAZAR AML-001 trial: Oral Azacitidine maintenance in AML





### 10 day Decitabine







# Combination of venetoclax with 10 day Decitabine

- Pts with TP53mut
  - lower rate of CR/CRi at 54% vs. 76% in pts with TP53WT (p=.015)
  - lower median OS at 5.2 months vs.19.4 mo in *TP53*<sup>WT</sup> AML (HR 4.68, p <.001)</li>



### APR-246 in TP53 mutated AML

- APR-246: novel agent that may restore the transcriptional activity of mutant p53 and induce apoptosis
- Ph I/II studies showed CR rates of 60 to 80% with deep molecular remission in CR patients
- Phase III trial: APR-246 with azacitidine (AZA)
   vs. AZA alone in TP53 mutant MDS
  - The trial failed to meet its primary endpoint of complete remission rate
  - CR rate 53% higher in APR-246 with AZA arm vs.
     AZA alone, but not statistically significant



### Magrolimab in TP53 mutated AML

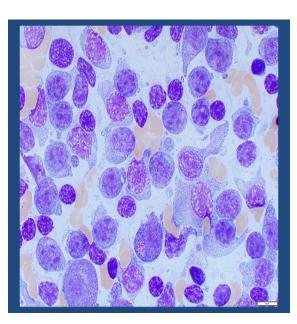
- Magrolimab: monoclonal antibody against CD47 that blocks the "don't eat me" signal used by cancer cells to avoid being ingested by macrophages
- Ph I b study: Magrolimab with Aza:
  - 75% CR+CRi
  - 6 mo OS 91% in TP53 mutant AML
- Ongoing ENHANCE study: A Randomized, Double-blind, Multicenter Study Comparing Magrolimab and Aza Vs. Aza Plus Placebo Higher Risk MDS

Sallman et al. ASCO abstract 2020



### Patient case 3

- 68 y/M with multiple myeloma s/p an autologous HCT; on lenalidomide maintenance
- H/o Type II DM, HTN and Renal dysfunction (creatinine 2)
- BM biopsy for evaluation of cytopenias
  - 29% blasts by flow, AML with MRC
  - Cytogenetics-Normal Male
  - Next generation sequencing- IDH 1 and SRSF2





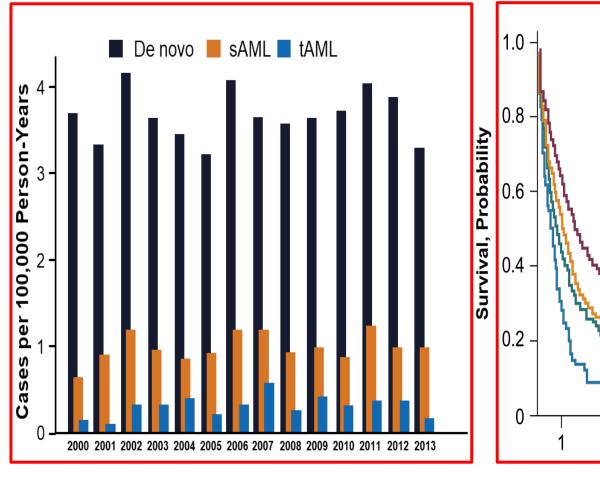
### Patient case 3 (contd)-

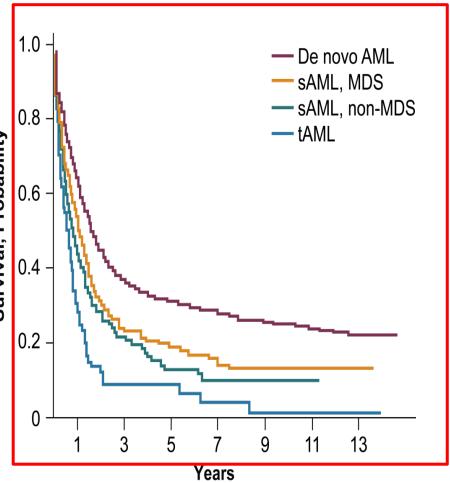
- Options discussed:
  - Induction chemotherapy
  - CPX351
  - Hypomethylating agent+/- venetoclax
- Started on Decitabine d/t poor performance status; continued to have circulating blasts 60 to 70%
- Developed systolic heart failure and sepsis
- Switched to ivosidenib after 2 cycles: response for 2 months followed by rapid increase in WBC count; possible differentiation syndrome
- Declined rapidly-enrolled in hospice



# SECONDARY AND THERAPY RELATED AML/ AML WITH TARGETABLE MUTATIONS

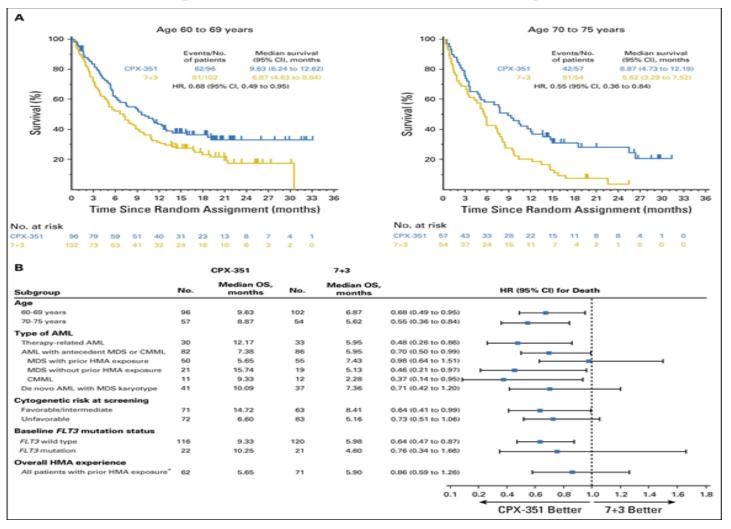
# Need for Additional Options in Secondary and Treatment-Related AML





#### MAYO CLINIC

# **CPX-351 vs. 7+3 in Older Patients With Newly Diagnosed Secondary AML**





### **IDH1/2 Targeted therapy**

- Ivosidenib and Enasidenib
  - monotherapy for the treatment of newly diagnosed (elderly/unfit) and relapsed/refractory IDH1 or IDH2 mutant AML, respectively
    - Differentiation syndrome: potentially fatal AE that produces a rapid increase in the differentiation of neutrophils after the removal of the differentiation block in the malignant clone
    - managed by discontinuation and treatment with glucocorticoids and/or hydroxyurea
  - Ongoing trials adding them to 7+3 for induction in fit patients or hypomethylating agents in older patients

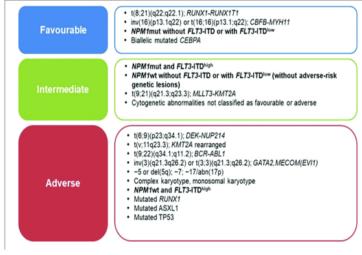


### Patient case 4

- 20 y/F with shortness of breath and dry cough
  - CT scan with patchy opacities
  - cytopenic with Platelets 55 and Hb 7.8 with normal WBC
  - BM biopsy showed AML with 24% blasts with t(8;21); RUNX1-RUNX1T1; Kit mutation negative
- Plan to treat her with 7+3
   +Gemtuzumab Ozogamicin



#### Risk Stratification for AML



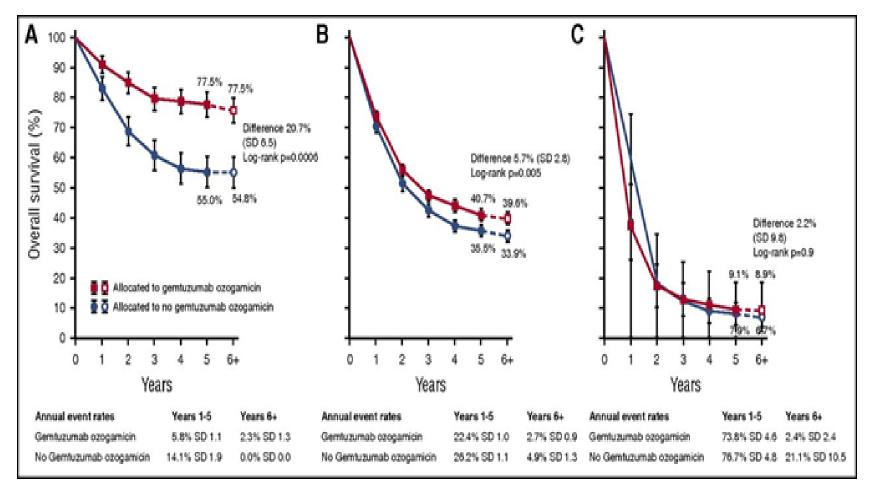
Dohner et al. Blood 2017



# FAVORABLE RISK/ CORE BINDING FACTOR AML

#### MAYO CLINIC

## Addition of Gemtuzumab Ozogamicin (CD33 antibody) to induction chemo



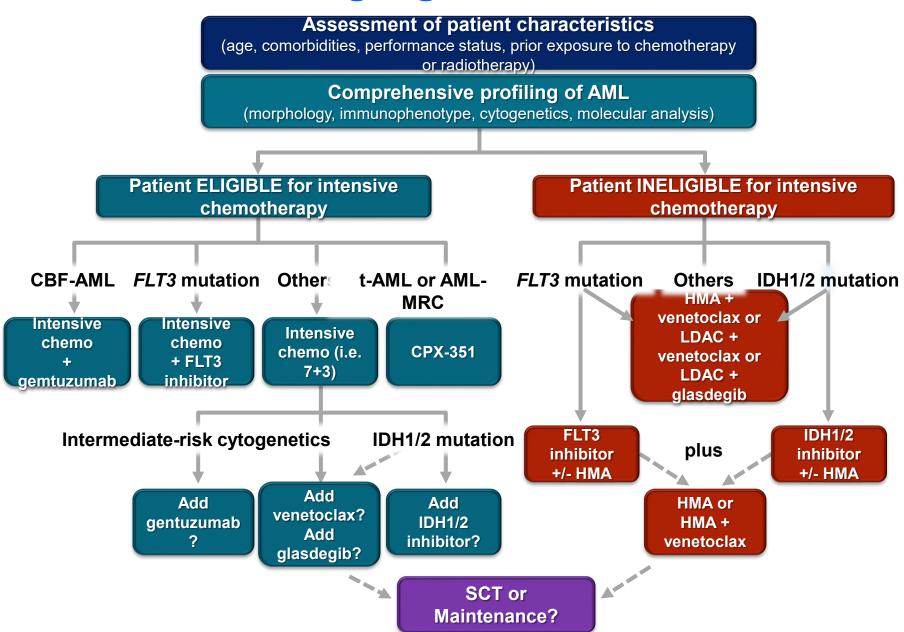


#### **Consolidation in CBF Leukemias**

- Most patients will not need allogeneic HCT for consolidation
  - Possible exceptions:
    - Kit mutation +
    - MRD+ disease by PCR
    - Additional mutations +
    - Therapy related CBF AML
- Consolidation is usually anthracycline and cytarabine with GO



### **MAYO CLINIC Evolving algorithm for AML**





### **Summary**

- Improvement in outcomes of AML though certain groups still have poor outcomes
- Rapidly evolving diagnostics and therapeutics
  - Combination of conventional chemo + targeted therapies+/- immunotherapy (Bispecific antibodies)+/- cell therapies
- Complicated therapy and requires special expertise
  - Better treated in specialized academic centers
  - Individualized management based on comorbidity and molecular/ genetic subtype



**Questions??** 



#### **Extra slides**



#### **BCL2** in AML

- BCL2 inhibits apoptosis in normal and malignant cells
- BCL2 is overexpressed in AML cells
- Early BCL2 inhibitors

   (navitoclax) also inhibited
   BCL<sub>XL</sub>, which contributed to toxicity (thrombocytopenia)
- BCL2 inhibitor venetoclax is a BH3 mimetic without activity against BCL<sub>x1</sub>

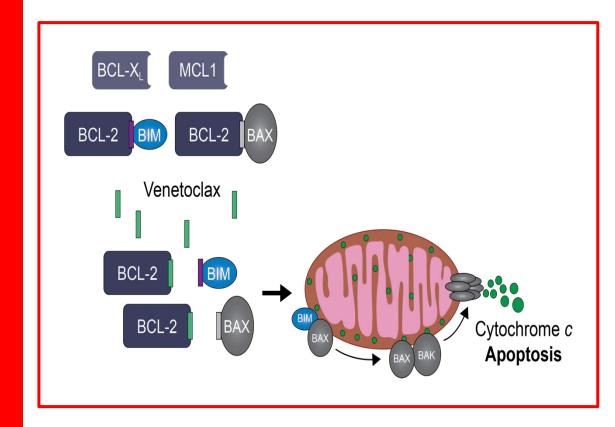




Figure. Frequency of Mutations by AML Subgroups

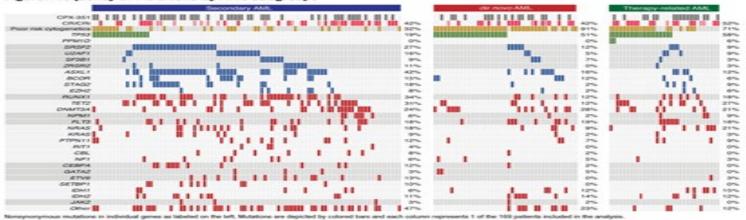


Table. Outcomes for Patients with the Most Frequently Occurring Mutations\*

	ASXL1		DNMT3A		RUNX1		TET2		TP53	
Outcome	CPX-351 (n = 30)	7+3 (n = 20)	CPX-351 (n = 20)	7+3 (n = 21)	CPX-351 (n = 21)	7+3 (n = 22)	CPX-351 (n = 26)	7+3 (n = 17)	CPX-351 (n = 24)	7+3 (n = 35)
CR, n (%)	5 (17)	4 (20)	7 (35)	11 (52)	5 (24)	6 (27)	5 (19)	7 (41)	7 (29)	12 (34)
OR (95% CI)	0.80 (0.19-3.43)		0.49 (0.14-1.72)		0.83 (0.21-3.29)		0.34 (0.09-1.34)		0.79 (0.26-2.43)	
CR+CRi, n (%)	11 (37)	7 (35)	12 (60)	12 (57)	7 (33)	7 (32)	9 (35)	8 (47)	7 (29)	14 (40)
OR (95% CI)	1.08 (0.33-3.50)		1.13 (0.32-3.90)		1.07 (0.30-3.84)		0.60 (0.17-2.08)		0.62 (0.20-1.87)	
Median remission duration,* mo	6.37	4.11	9.89	4.32	8.05	3.45	6.37	3.45	8.05	3.45
HR (95% CI)	0.69 (0.18-2.58)		0.33 (0.10-1.06)		0.56 (0.17-1.87)		0.43 (0.13-1.38)		0.63 (0.24-1.65)	
Transplant, n (%)	8 (27)	6 (30)	11 (55)	8 (38)	6 (29)	4 (18)	6 (23)	3 (18)	3 (13)	11 (31)
OR (95% CI)	0.85 (0.24-2.97)		1.99 (0.57-6.90)		1.80 (0.43-7.59)		1.40 (0.30-6.56)		0.31 (0.08-1.27)	
Median OS,* mo	9.10	6.29	12.62	5.49	8.87	4.09	9.10	3.68	4.53	5.13
HR (95% CI)	0.67 (0.35-1.27)		0.41 (0.19-0.89)		0.58 (0.30-1.11)		0.47 (0.23-0.93)		1.19 (0.70-2.05)	
Median EFS,* mo	1.58	1.41	5.98	3.58	2.00	1.22	1.59	1.64	0.97	1.64
HR (95% CI)	0.79 (0.42-1.48)		0.45 (0.21-0.95)		0.57 (0.30-1.08)		0.93 (0.49-1.77)		1.13 (0.66-1.93)	

\*Mutations reported for ±20% of patients overall.

\*Median remission duration, GS, and EFS are based on Kaplan-Moler estimates.



### **Azacitidine Maintenance post HCT**

Azacitidine Maintenance after Allogeneic Hematopoietic Stem Cell Transplantation in High Risk AML and MDS Patients: Outcomes of a phase III Randomized Clinical Trial

Screening period: Days 40-100 after alogeneic transplant.

5-azacitidine 32mg/m2/dayX5

Patient population: High risk AML/MDS CMML Aged 18-75 CR after allo-HSCT observation

Follow up until:

Completion of 12 cycles of maintenance
Relapse/death
Discontinuation of maintenance

#### Population:

187 enrolled and randomized:

94 observation

93 5-azacitidine

87 started the 5-azacitidine maintenance Median number of cycles=4

#### Statistics:

Primary outcome: RFS

Secondary outcomes: OS, aGvHD and

toxicity

Efficacy endpoint	5-azacitidine, n=87	Observation, n=94	HR, 95%CI, p
RFS	2.07 yr	1.28 yr	0.77, 0.51-1.14, 0.19
OS	2.52 yr	3.56 yr	0.84, 0.56-1.28, 0.43

#### Conclusion:

- 5-azacitidine given as 32 mg/m2/dayX5 did not lead to improved RFS or OS.
- · There was no safety concern.

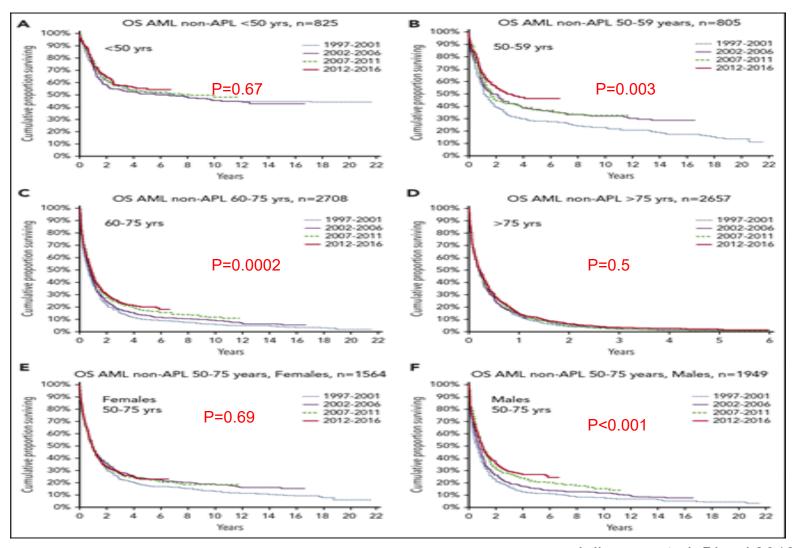


## Options for relapsed refractory disease

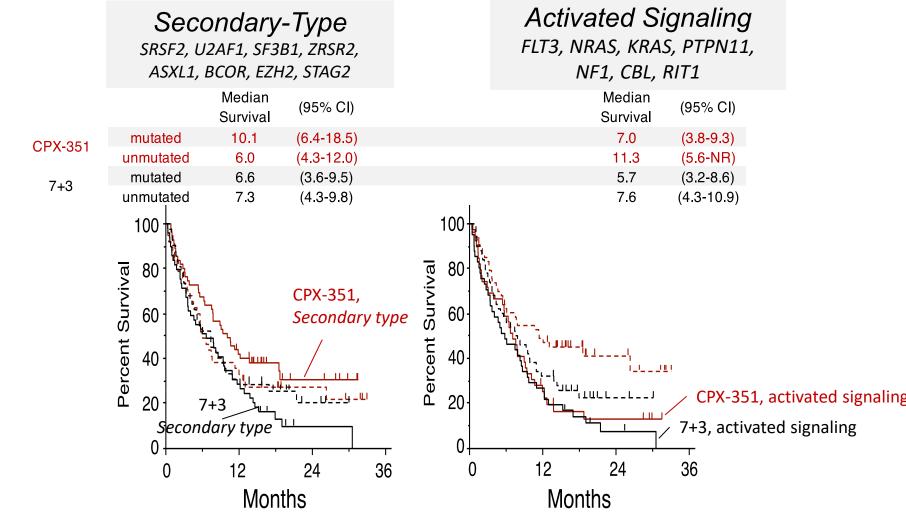
- Salvage chemotherapy
- Gemtuzumab Ozogamicin
- Hypomethylating agents+/-venetoclax
- LDAC with venetoclax
- Targeted agents (if not used earlier)



### Survival for AML over the years

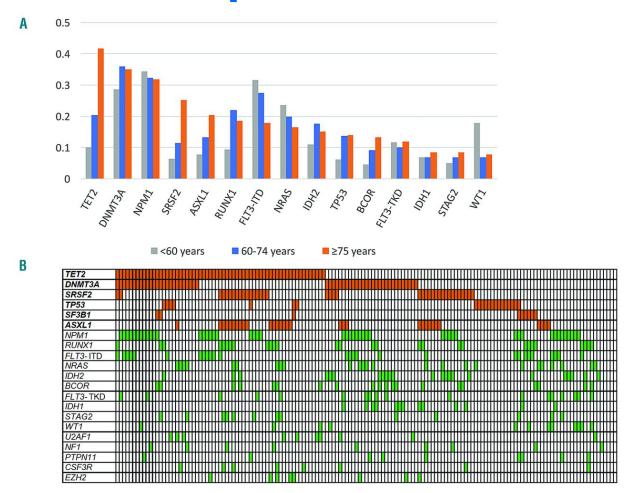


## 一〇verall survival in Secondary-type and activated signaling mutations



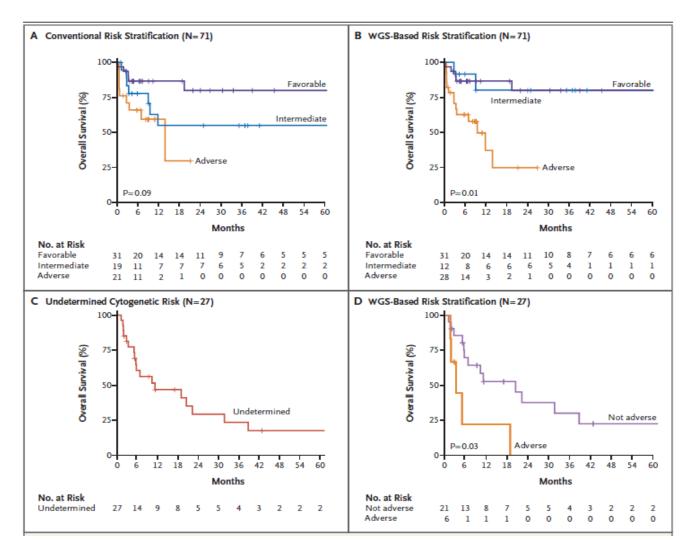


## Genetic landscape of old AML patients





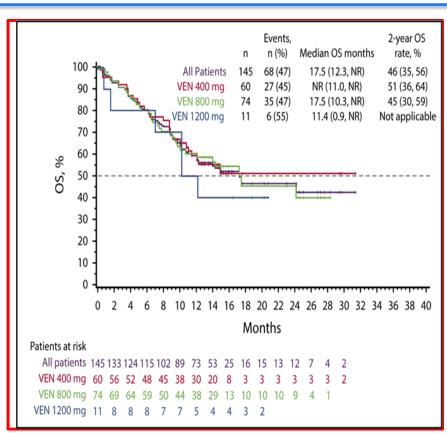
### Risk Assessment by WGS





#### **Venetoclax Plus HMA Phase 2 Trial**

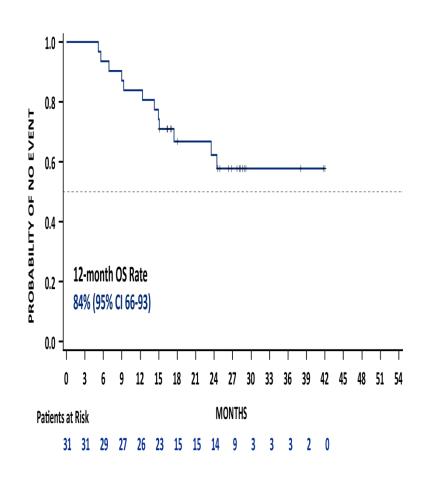
Cohort	n	CR + Cri, %	Median CR/CRi Duration, mo (95% CI)	Median OS, mo (95% CI)
All patients	145	67	11.3	17.5
Venetoclax 400 mg/HMA	60	73	12.5	NR (11.0-NR)
Aged 65-74 y	83	69	12.9	17.7
Aged ≥75 y	62	65	9.2	11
De novo AML	109	67	9.4	12.5
Secondary AML	36	67	NR (12.5-NR)	NR (14.6-NR)



## **Polition** of HCT in patients after venetoclax based regimens

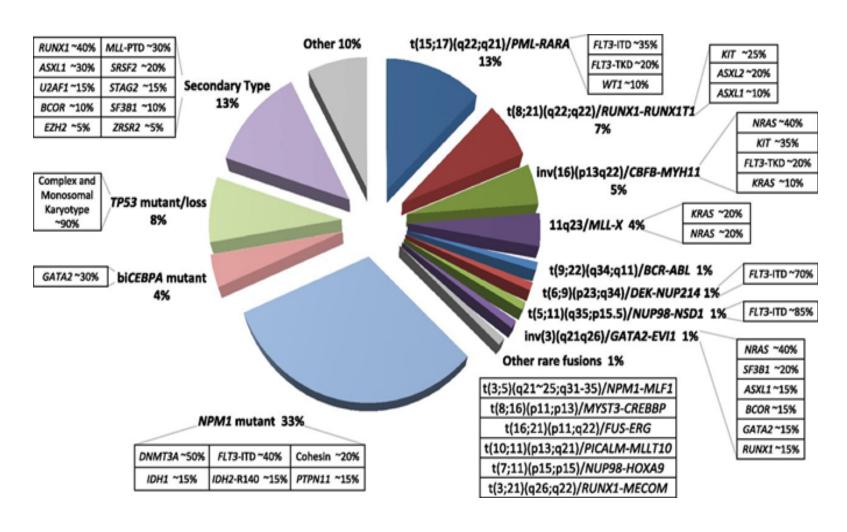
#### Secondary analysis (n=304)

- Open-label phase 1b: venetoclax
   + azacitidine/decitabine
- Open-label phase 1/2: venetoclax
   + LDAC
- 10 % (31/304) patients received HCT
  - 68% (21/31) of patients remained alive at 12 months post-transplant
  - 55% (17/31) of all patients that had HCT had posttransplant remission of ≥12 months
  - 71% (12/17) of those patients remained in remission for ≥2 years



#### MAYO CLINIC

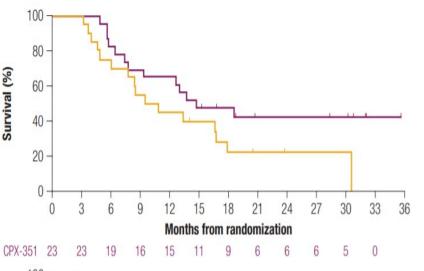
# Molecular landscape of AML in younger adults



### MAYO CLINIC

## With sAML and Prior HMA Exposure<sup>1</sup>

OS in AML Pts With Prior HMA Exposure Who Achieved CR or CRi





OS Landmarked From the Date of HCT in AML Patients With Prior HMA Exposure Who Achieved CR or CRi

