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| CLINICAL Utility of Molecular Testing in  aml WITH *KMT2A* REARRANGEMENT  Diagnostic Utility  AML with balanced rearrangements involving the *KMT2A* gene at chromosome 11q23 account for approximately 3% of adult cases1,2 and 16%-18% of paediatric cases3,4. This is a recurrent genetic abnormality that defines AML irrespective of blast count (WHO 5th edition)5.  *KMT2A* rearrangements are also recurrently observed in myeloid neoplasm post cytotoxic therapy (MN-pCT, classified separately), B-ALL, T-ALL and mixed-phenotype acute leukaemia.  *KMT2A* rearrangements typically result in a *KMT2A-*encoded amino-terminus partnering with a carboxy-terminus encoded by the partner gene, and a gene expression profile characterised by overexpression of *HOX* genes.  Over 100 *KMT2A* fusion partners have been identified, with the most common in AML being *MLLT3* from t(9;11)(p22;q23), *MLLT10* from t(10;11)(p12;q23), *ELL* from t(11;19)(p13.1;q23), and *AFDN* from t(6;11)(q27;q23)6.  *KMT2A*-rearranged AML is associated with additional somatic mutations commonly involving the RAS pathway (including *KRAS*, *NRAS* and *PTPN11*) and *FLT3*-TKD2,7-9.  Separate to structural *KMT2A* rearrangements involving chromosomal translocations, cryptic partial tandem duplication of *KMT2A* (*KMT2A*-PTD) has also been described, typically in the setting of trisomy 11 or a normal karyotype10. This is not currently recognised as a distinct AML category.  Prognostic Utility  In the 2022 ELN classification, AML with t(9;11)(p21.3;q23.3)/*KMT2A::MLLT3* carries an intermediate prognosis, while non-*MLLT3* rearrangements [t(v;11q23.3)/*KMT2A*-rearranged] are designated as adverse-risk11.  Although not currently recommended by the 2021 ELN MRD guidelines12, *KMT2A* rearrangements may be amenable to molecular measurable residual disease (MRD) monitoring to provide independent prognostication post therapy for AML13,14, but are complicated by variable breakpoints and multiple fusion partners.  biomarkers of response to therapy  The interaction between KMT2A fusion protein and its critical oncogenic cofactor, menin, can be targeted using small molecule inhibitors of menin, which have demonstrated potent pre-clinical efficacy15 and shown promising activity in early-phase clinical trials16.  *FLT3* mutations are the target of midostaurin17 (*FLT3*-ITD and TKD) (clinical trials included only TKD mutations at Asp835 and Ile836 codons), quizartinib (*FLT3*-ITD only)18 in newly diagnosed AML, and gilteritinib19 in relapsed/refractory AML.  *FLT3* testing should be repeated at relapse/progression as ~20% of patients have a change (gain or loss) in mutation status20.  *IDH1* (Arg132) and *IDH2* (both Arg140 and Arg172) mutations are the target of IDH1 and IDH2 inhibitors, respectively21.  Several mutations have been described in patients with acquired resistance to targeted inhibitors such as *FLT3* Phe691Leu (FLT3 inhibitors)22, second-site IDH1/IDH2 mutations (IDH1/IDH2 inhibitors)23, *BAX* (BCL2 inhibitors)24, and *MEN1* (menin inhibitors)25.  References  **1.** Schoch C, et al. AML with 11q23/MLL abnormalities as defined by the WHO classification: incidence, partner chromosomes, FAB subtype, age distribution, and prognostic impact in an unselected series of 1897 cytogenetically analyzed AML cases. *Blood* 2003; **102**(7): 2395-402. **2.** Papaemmanuil E, et al. Genomic Classification and Prognosis in Acute Myeloid Leukemia. *N Engl J Med* 2016; **374**(23): 2209-21. **3.** Raimondi SC, et al. Chromosomal abnormalities in 478 children with acute myeloid leukemia: clinical characteristics and treatment outcome in a cooperative pediatric oncology group study-POG 8821. *Blood* 1999; **94**(11): 3707-16. **4.** Harrison CJ, et al. Cytogenetics of childhood acute myeloid leukemia: United Kingdom Medical Research Council Treatment trials AML 10 and 12. *J Clin Oncol* 2010; **28**(16): 2674-81. **5.** WHO Classification of Tumours Editorial Board. Haematolymphoid tumours. Lyon (France): International Agency for Research on Cancer; forthcoming. (WHO classification of tumours series, 5th ed.; vol. 11). https://publications.iarc.fr. **6.** Meyer C, et al. The KMT2A recombinome of acute leukemias in 2023. *Leukemia* 2023; **37**(5): 988-1005. **7.** Bill M, et al. Mutational landscape and clinical outcome of patients with de novo acute myeloid leukemia and rearrangements involving 11q23/KMT2A. *Proc Natl Acad Sci U S A* 2020; **117**(42): 26340-6. **8.** Yuen KY, et al. Mutational landscape and clinical outcome of pediatric acute myeloid leukemia with 11q23/KMT2A rearrangements. *Cancer Med* 2023; **12**(2): 1418-30. **9.** Issa GC, et al. Predictors of outcomes in adults with acute myeloid leukemia and KMT2A rearrangements. *Blood Cancer J* 2021; **11**(9): 162. **10.** Schnittger S, et al. Screening for MLL tandem duplication in 387 unselected patients with AML identify a prognostically unfavorable subset of AML. *Leukemia* 2000; **14**(5): 796-804. **11.** Dohner H, et al. Diagnosis and management of AML in adults: 2022 recommendations from an international expert panel on behalf of the ELN. *Blood* 2022; **140**(12): 1345-77. **12.** Heuser M, et al. 2021 Update on MRD in acute myeloid leukemia: a consensus document from the European LeukemiaNet MRD Working Party. *Blood* 2021; **138**(26): 2753-67. **13.** Liu J, et al. Monitoring mixed lineage leukemia expression may help identify patients with mixed lineage leukemia--rearranged acute leukemia who are at high risk of relapse after allogeneic hematopoietic stem cell transplantation. *Biol Blood Marrow Transplant* 2014; **20**(7): 929-36. **14.** Huang S, et al. Prognostic Significance of Mixed-Lineage Leukemia (MLL) Gene Detected by Real-Time Fluorescence Quantitative PCR Assay in Acute Myeloid Leukemia. *Med Sci Monit* 2016; **22**: 3009-17. **15.** Grembecka J, et al. Menin-MLL inhibitors reverse oncogenic activity of MLL fusion proteins in leukemia. *Nat Chem Biol* 2012; **8**(3): 277-84. **16.** Issa GC, et al. The menin inhibitor revumenib in KMT2A-rearranged or NPM1-mutant leukaemia. *Nature* 2023; **615**(7954): 920-4. **17.** Stone RM, et al. Midostaurin plus Chemotherapy for Acute Myeloid Leukemia with a FLT3 Mutation. *N Engl J Med* 2017; **377**(5): 454-64. **18.** Erba HP, et al. Quizartinib plus chemotherapy in newly diagnosed patients with FLT3-internal-tandem-duplication-positive acute myeloid leukaemia (QuANTUM-First): a randomised, double-blind, placebo-controlled, phase 3 trial. *Lancet* 2023; **401**(10388): 1571-83. **19.** Perl AE, et al. Gilteritinib or Chemotherapy for Relapsed or Refractory FLT3-Mutated AML. *N Engl J Med* 2019; **381**(18): 1728-40. **20.** Daver N, et al. Targeting FLT3 mutations in AML: review of current knowledge and evidence. *Leukemia* 2019; **33**(2): 299-312. **21.** Dohner H, et al. Diagnosis and management of AML in adults: 2017 ELN recommendations from an international expert panel. *Blood* 2017; **129**(4): 424-47. **22.** Smith CC, et al. Molecular profile of FLT3-mutated relapsed/refractory patients with AML in the phase 3 ADMIRAL study of gilteritinib. *Blood Adv* 2022; **6**(7): 2144-55. **23.** Intlekofer AM, et al. Acquired resistance to IDH inhibition through trans or cis dimer-interface mutations. *Nature* 2018; **559**(7712): 125-9. **24.** Moujalled DM, et al. Acquired mutations in BAX confer resistance to BH3-mimetic therapy in acute myeloid leukemia. *Blood* 2023; **141**(6): 634-44. **25.** Perner F, et al. MEN1 mutations mediate clinical resistance to menin inhibition. *Nature* 2023; **615**(7954): 913-9. |