

ABOUT THE TEST FoundationOne®Liquid CDx is a next generation sequencing (NGS) assay that identifies clinically relevant genomic alterations in circulating cell-free DNA.

PATIENT	DISEASE Pancreas ductal adenocarcinoma	PHYSICIAN	ORDERING PHYSICIAN Yeh, Yi-Chen	SPECIMEN	SPECIMEN ID LYL 10/17/1946
	NAME Lin, Le-Yeh		MEDICAL FACILITY Taipei Veterans General Hospital		SPECIMEN TYPE Blood
	DATE OF BIRTH 17 October 1946		ADDITIONAL RECIPIENT None		DATE OF COLLECTION 05 January 2024
	SEX Female		MEDICAL FACILITY ID 205872		SPECIMEN RECEIVED 09 January 2024
	MEDICAL RECORD # 49052417		PATHOLOGIST Not Provided		

Biomarker Findings

Blood Tumor Mutational Burden - 1 Muts/Mb
ctDNA Tumor Fraction - Low (< 1.0%)
Microsatellite status - MSI-High Not Detected

Genomic Findings

For a complete list of the genes assayed, please refer to the Appendix.

KRAS G12D
DNMT3A L93*, Y908fs*13, N489fs*162

This assay tested >300 cancer-related genes, including the following 2 gene(s) routinely assessed in this tumor type: **BRCA1**, **BRCA2**.

Report Highlights

- **Low ctDNA Tumor Fraction** was detected; in the absence of actionable driver alterations consider reflex testing to a regulated tissue test, such as FoundationOne®CDx (p. 5)
- Evidence-matched clinical trial options based on this patient's genomic findings: (p. 8)
- Variants that may represent clonal hematopoiesis and may originate from non-tumor sources: **DNMT3A** L93*, N489fs*162, Y908fs*13 (p. 7)

BIOMARKER FINDINGS

Blood Tumor Mutational Burden -
 1 Muts/Mb

ctDNA Tumor Fraction -
 Low (< 1.0%)

Microsatellite status -
 MSI-High Not Detected

GENOMIC FINDINGS

VAF%

KRAS - G12D 0.15%

10 Trials see p. 8

THERAPY AND CLINICAL TRIAL IMPLICATIONS

No therapies or clinical trials. See Biomarker Findings section

Low ctDNA Tumor Fraction. This result does not compromise confidence in any reported alterations. See Biomarker Finding Summary.

MSI-High not detected. No evidence of microsatellite instability in this sample (see Appendix section).

THERAPIES WITH CLINICAL RELEVANCE (IN PATIENT'S TUMOR TYPE)

None

THERAPIES WITH CLINICAL RELEVANCE (IN OTHER TUMOR TYPE)

None

VARIANTS THAT MAY REPRESENT CLONAL HEMATOPOIESIS (CH)

Genomic findings below may include nontumor somatic alterations, such as CH. The efficacy of targeting such nontumor somatic alterations is unknown. This content should be interpreted based on clinical context. Refer to appendix for additional information on CH.

DNMT3A - L93*, Y908fs*13, N489fs*162 p. 7

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Electronically signed by Richard Hickman, MD | 16 January 2024
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GENOMIC FINDINGS WITH NO REPORTABLE THERAPEUTIC OR CLINICAL TRIAL OPTIONS

For more information regarding biological and clinical significance, including prognostic, diagnostic, germline, and potential chemosensitivity implications, see the Genomic Findings section.

DNMT3A - L93*, Y908fs*13, N489fs*162 **p. 7**

NOTE Genomic alterations detected may be associated with activity of certain approved therapies; however, the therapies listed in this report may have varied clinical evidence in the patient's tumor type. Therapies and the clinical trials listed in this report may not be complete and/or exhaustive. Neither the therapies nor the trials identified are ranked in order of potential or predicted efficacy for this patient, nor are they ranked in order of level of evidence for this patient's tumor type. This report should be regarded and used as a supplementary source of information and not as the single basis for the making of a therapy decision. All treatment decisions remain the full and final responsibility of the treating physician and physicians should refer to approved prescribing information for all therapies. Therapies contained in this report may have been approved by the US FDA or other national authorities; however, they might not have been approved in your respective country. In the appropriate clinical context, germline testing of *APC, ATM, BAP1, BRCA1, BRCA2, BRIP1, CHEK2, FH, FLCN, MEN1, MLH1, MSH2, MSH6, MUTYH, NF1, NF2, PALB2, PMS2, POLE, PTEN, RAD51C, RAD51D, RB1, RET, SDHA, SDHB, SDHC, SDHD, SMAD4, STK11, TGFBR2, TP53, TSC1, TSC2, VHL, and WT1* is recommended.

Variant Allele Frequency is not applicable for copy number alterations.

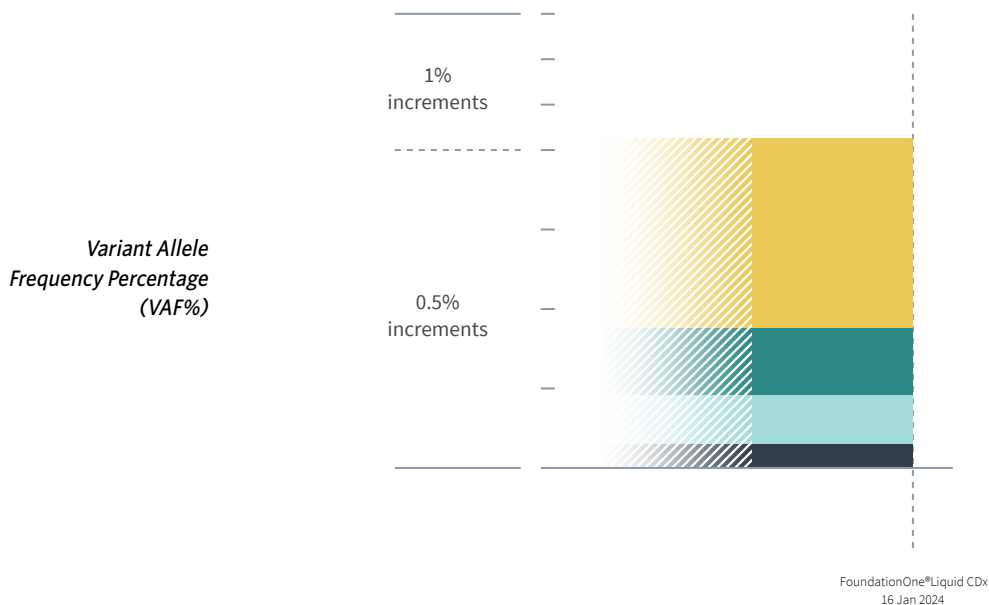
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ORDERED TEST # ORD-1794443-01



HISTORIC PATIENT FINDINGS (Biomarker Findings)		ORD-1794443-01
Blood Tumor Mutational Burden		1 Muts/Mb
Microsatellite status		MSI-High Not Detected
ctDNA Tumor Fraction		< 1.0%
HISTORIC PATIENT FINDINGS (Genomic Findings)		VAF%
KRAS	● G12D	0.15%
DNMT3A	● L93*	0.42%
	● N489fs*162	1.4%
	● Y908fs*13	0.31%

IMPORTANT NOTE This comparison table refers only to genes and biomarkers assayed by prior FoundationOne®Liquid CDx or FoundationOne®CDx tests. Up to five previous tests may be shown.

For some genes in FoundationOne Liquid CDx, only select exons are assayed. Therefore, an alteration found by a previous test may not have been confirmed despite overlapping gene lists. Please refer to the Appendix for the complete list of genes and exons assayed. Variants reported for prior time points reflect reporting practices at the time of the historical test(s). Changes in variant reporting nomenclature, classification, or handling may result in the appearance of discrepancies across time points. The gene and biomarker list will be updated periodically to reflect new knowledge about cancer biology.

ctDNA Tumor Fraction may include previous Tumor Fraction results which reflect reporting practices at the time of reporting. Changes in biomarker reporting may result in the appearance of discrepancies across time points.

As new scientific information becomes available, alterations that had previously been listed as Variants of Unknown Significance (VUS) may become reportable or reportable variants may become VUS.

Tissue Tumor Mutational Burden (TMB) and blood TMB (bTMB) are estimated from the number of synonymous and non-synonymous single-nucleotide variants (SNVs) and insertions and deletions (indels) per area of coding genome sampled, after the removal of known and likely oncogenic driver events and germline SNPs. Tissue TMB is calculated based on variants with an allele frequency of ≥5%, and bTMB is calculated based on variants with an allele frequency of ≥0.5%.

Not Tested = not baited, not reported on test, or test preceded addition of biomarker or gene

Not Detected = baited but not detected on test

Detected = present (VAF% is not applicable)

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VAF% = variant allele frequency percentage

Cannot Be Determined = Sample is not of sufficient data quality to confidently determine biomarker status

Please note that other aspects of this table may have changed from the previous version to reflect the most up-to-date reporting information.

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BIOMARKER FINDINGS

BIOMARKER

Blood Tumor Mutational Burden

RESULT

1 Muts/Mb

POTENTIAL TREATMENT STRATEGIES

— Targeted Therapies —

On the basis of clinical evidence in solid tumors, increased blood tumor mutational burden (bTMB) may be associated with greater sensitivity to immunotherapeutic agents, including anti-PD-L1¹⁻⁵, anti-PD-1^{2,5-8}, anti-PD-1/CTLA4 therapies^{2,6}, anti-PD-L1/CTLA4 therapies^{1,9-13}. A Phase 2 multi-solid-tumor trial showed that bTMB ≥ 16 Muts/Mb (as measured by this assay) was associated with improved survival from treatment with a PD-1 inhibitor alone or in combination with a CTLA-4 inhibitor⁶. In non-small cell lung cancer (NSCLC), multiple clinical trials have shown patients with higher bTMB derive clinical benefit from immune checkpoint inhibitors following single-agent or combination treatments with either CTLA4

inhibitors or chemotherapy, with reported high bTMB cutpoints ranging from 6 Muts/Mb-16 Muts/Mb^{3,11-13}. In head and neck squamous cell carcinoma (HNSCC), a Phase 3 trial showed that bTMB ≥ 16 Muts/Mb (approximate equivalency ≥ 8 Muts/Mb as measured by this assay) was associated with improved survival from treatment with a PD-L1 inhibitor alone or in combination with a CTLA-4 inhibitor¹. In colorectal cancer (CRC), a Phase 2 study showed that bTMB ≥ 28 Muts/Mb (approximate equivalency ≥ 14 Muts/Mb as measured by this assay) was associated with improved OS from a PD-L1 inhibitor alone or in combination with a CTLA-4 inhibitor⁹⁻¹⁰.

FREQUENCY & PROGNOSIS

Among pancreatic cancer cases profiled by F1LCDx, 2.1% of cases had a blood tumor mutational burden (bTMB) of >10 Muts/Mb¹⁴. Published data investigating the prognostic implications of bTMB levels in pancreatic carcinoma are limited (PubMed, Jul 2023). A study of patients with pancreatic ductal adenocarcinoma harboring MMR gene mutations reported improved prognosis for patients with high tumor mutational burden (TMB) measured in tissue

samples (defined as >50 mutations; survival 69-314 months) compared with patients with lower TMB (average of 5.7 mutations; 10-42 months)¹⁵.

FINDING SUMMARY

Blood tumor mutational burden (bTMB, also known as mutation load) is a measure of the number of somatic protein-coding base substitution and insertion/deletion mutations from circulating tumor DNA in blood. TMB is affected by a variety of causes, including exposure to mutagens such as ultraviolet light in melanoma¹⁶⁻¹⁷ and cigarette smoke in lung cancer¹⁸⁻¹⁹, treatment with temozolomide-based chemotherapy in glioma²⁰⁻²¹, mutations in the proofreading domains of DNA polymerases encoded by the POLE and POLD1 genes²²⁻²⁶, and microsatellite instability (MSI)^{22,25-26}. High bTMB levels were not detected in this sample. It is unclear whether the bTMB levels in this sample would be predicted to be associated with sensitivity to PD-1- or PD-L1-targeting immune checkpoint inhibitors, alone or in combination with other agents^{3-4,8,27-28}. Depending on the clinical context, TMB testing of an alternate sample or by another methodology could be considered.

BIOMARKER

ctDNA Tumor Fraction

RESULT

Low ($< 1.0\%$)

POTENTIAL TREATMENT STRATEGIES

— Targeted Therapies —

Specimens with low circulating-tumor DNA (ctDNA) tumor fraction have reduced positive predictive agreement and negative predictive value compared with specimens with high ctDNA tumor fraction²⁹. In a study of advanced non-small cell lung cancer (NSCLC), additional follow-up tissue testing identified driver alterations in 51% of patients with a low ctDNA tumor fraction²⁹. When high ctDNA tumor fraction is not detected, it does not exclude the presence of disease burden or compromise the confidence of reported alterations. A negative result does not rule out the presence of

a mutation below the limits of detection of the assay. Patients for whom no companion diagnostic alterations are detected should be considered for confirmation with an FDA-approved or appropriately validated in other countries tumor tissue test, if available. Single observations or changes over time of circulating-tumor DNA (ctDNA) quantity are not currently part of any clinical decision-making guidelines but may be a useful indicator for future cancer management³⁰⁻³⁷.

FREQUENCY & PROGNOSIS

In a large genomic study of 25 solid tumor types, 69% of liquid biopsy samples had ctDNA levels $>1\%$ as measured by an investigational composite tumor fraction algorithm with a median tumor fraction of 2.2% across tumor types³⁸. Median ctDNA levels were reported to be highest in small cell lung cancer, liver, colon, and bladder tumor types and lowest in glioma and appendiceal cancers³⁸. Higher ctDNA levels were reported for patients with metastatic (Stage 4) tumors compared with patients with localized disease (Stages 1 to 3)³⁹. Higher ctDNA levels have been reported to be

associated with worse prognosis in a variety of advanced solid tumors⁴⁰, including non-small cell lung cancer (NSCLC)⁴¹, colorectal cancer (CRC)⁴¹⁻⁴², pancreatic cancer⁴³, Ewing sarcoma and osteosarcoma⁴⁴, prostate cancer^{35,41,45}, breast cancer^{41,46}, leiomyosarcoma⁴⁷, esophageal cancer⁴⁸, and gastrointestinal cancer⁴⁹.

FINDING SUMMARY

The ctDNA tumor fraction provides an estimate of the percentage of circulating tumor DNA (ctDNA) present in a cell-free DNA (cfDNA) sample. The ctDNA tumor fraction algorithm utilized for FoundationOne Liquid CDx integrates multiple distinct genomic features, including aneuploidy and the observed allele frequencies of somatic short variants and rearrangements. Low ctDNA tumor fraction ($<1.0\%$) was detected in this sample. For patients with a negative liquid biopsy result with low ctDNA tumor fraction, reflex tissue testing should be considered to confirm tumor mutation status, if feasible²⁹.

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ORDERED TEST # ORD-1794443-01

GENOMIC FINDINGS

GENE
KRAS

ALTERATION
G12D

HGVS VARIANT
NM_004985.3:c.35G>A (p.G12D)

VARIANT CHROMOSOMAL POSITION
chr12:25398284

POTENTIAL TREATMENT STRATEGIES

— Targeted Therapies —

For patients with pancreatic cancer, MEK inhibitor combinations are under investigation. A Phase 2 study of trametinib with pembrolizumab versus gemcitabine after stereotactic body radiotherapy (SBRT) reported increased median OS (mOS, 14.9 months vs. 12.8 months, HR=0.69) benefit for patients with KRAS-mutated, PD-L1 positive disease⁵⁰. Combination MEK/autophagy inhibitors are also under investigation based on preclinical evidence of increased autophagy downstream of KRAS-mutated pancreatic tumors⁵¹⁻⁵². A heavily pretreated patient with pancreatic cancer treated with trametinib plus hydroxychloroquine experienced a PR⁵¹. A Phase 2 study of the reoviral agent pelareorep with gemcitabine for patients with pancreatic cancer reported 1 PR, 23 SDs, and 5 PDs for 34 patients with a favorable median OS of 10.2 months⁵³. A Phase 1b study of second-line pelareorep with pembrolizumab and chemotherapy reported 1 PR of 17.4 months and a DCR of 30% (3/10) (0⁵⁴; an earlier study reported no benefit from

pelareorep in combination with paclitaxel/carboplatin⁵⁵. Trials combining MEK inhibitors with other targeted therapies, such as EGFR inhibitors⁵⁶ or PI3K-AKT pathway inhibitors⁵⁷⁻⁶⁰, reported no PRs and frequent adverse events for patients with KRAS-mutated pancreatic cancer. Clinical trials combining various MEK inhibitors with gemcitabine reported no additional benefit compared to gemcitabine alone irrespective of KRAS mutation status⁶¹⁻⁶⁴, despite promising results in earlier trials of MEK inhibitor monotherapies⁶⁵⁻⁷¹. Preclinical data suggests that KRAS G12D mutations may predict sensitivity to KRAS G12D small-molecule inhibitors, such as MRTX1133⁷²⁻⁷⁶ and RMC9805⁷⁷. Preclinical and clinical data suggest that solid tumors with KRAS mutations, such as G12D and G12V, may benefit from adoptive cell therapy targeting these specific KRAS mutations⁷⁸⁻⁸¹. KRAS G12D-targeted adoptive cell therapy has yielded PRs for 3 pretreated patients with metastatic pancreatic adenocarcinoma⁷⁸, colorectal cancer (CRC)⁷⁹, and non-small cell lung cancer (NSCLC)⁸², respectively. Multiple studies of MEK inhibitors, either as a single-agent or in combination with chemotherapy, have reported low response rates or response rates similar to those of chemotherapy alone for patients with KRAS-mutated non-small cell lung cancer (NSCLC)⁸³⁻⁸⁷; however, limited clinical data support investigational approaches targeting MEK in KRAS-mutated solid tumors including the combination of the MEK inhibitor mirdametinib and the CDK4/6 inhibitor palbociclib⁸⁸ and the dual MEK-pan-RAF inhibitor CH5126766 alone or with the FAK inhibitor defactinib⁸⁹⁻⁹¹. Additional approaches to treat RAS-addicted solid tumors

include targeting SOS1 (BI-3406, MRTX0902, BI-1701963, and BAY-293)⁹²⁻¹⁰² or SHP2 (RMC-4630, TNO155)^{40,103-106}, either alone or in combination with other targeted therapies; clinical benefit has been observed following treatment with RMC-4630 across KRAS mutations (including mutations at G12)¹⁰³. A Phase 1 study of the combination of nivolumab, ipilimumab, and pooled synthetic long peptide vaccines targeting KRAS codon 12 mutations (G12D, G12R, G12V, G12A, G12C, and G13D) reported a median disease-free survival of 6.4 months for patients with KRAS G12 codon-mutated pancreatic ductal adenocarcinoma¹⁰⁷.

FREQUENCY & PROGNOSIS

KRAS mutations have been observed in 91-95% of pancreatic ductal adenocarcinoma cases¹⁰⁸⁻¹⁰⁹, with the majority of mutations found at codon 12¹¹⁰⁻¹¹³. KRAS mutations, particularly G12D, have been associated with decreased median survival time in patients with pancreatic ductal adenocarcinoma¹¹¹.

FINDING SUMMARY

KRAS encodes a member of the RAS family of small GTPases. Activating mutations in RAS genes can cause uncontrolled cell proliferation and tumor formation¹¹⁴⁻¹¹⁵. KRAS alterations affecting amino acids G12, G13, Q22, P34, A59, Q61, and A146, as well as mutations G10_A11insG, G10_A11insAG (also reported as G10_A11dup and G12_G13insAG), A18D, L19F, D33E, G60_A66dup/E62_A66dup, E62K, E63K, R68S, K117R, and K117N have been characterized as activating and oncogenic^{114,116-138}.

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ORDERED TEST # ORD-1794443-01

GENOMIC FINDINGS
GENE

DNMT3A

ALTERATION

L93*, Y908fs*13, N489fs*162

HGVS VARIANT

NM_022552.3:c.278T>A (p.L93*),

NM_022552.3:c.2722dup (p.Y908Lfs*13),

NM_022552.3:c.1464del (p.N489Tfs*162)

VARIANT CHROMOSOMAL POSITION

chr2:25505480, chr2:25457164, chr2:25468898-25468899

POTENTIAL TREATMENT STRATEGIES
— Targeted Therapies —

There are no targeted therapies available to address genomic alterations in DNMT3A in solid tumors.

FREQUENCY & PROGNOSIS

DNMT3A alterations have been reported at relatively low frequencies in solid tumors and are more prevalent in hematological malignancies (cBioPortal, COSMIC, PubMed, Feb 2023)¹³⁹⁻¹⁴¹. Published data investigating the prognostic implications of DNMT3A alterations in solid tumors are limited (PubMed, Feb 2023).

FINDING SUMMARY

The DNMT3A gene encodes the protein DNA methyltransferase 3A, an enzyme that is involved in the methylation of newly synthesized DNA, a function critical for gene regulation¹⁴²⁻¹⁴³. The role of DNMT3A in cancer is uncertain, as some reports describe increased expression and contribution to tumor growth, whereas others propose a role for DNMT3A as a tumor suppressor¹⁴⁴⁻¹⁴⁹. Alterations such as seen here may disrupt DNMT3A function or expression¹⁵⁰⁻¹⁵³.

POTENTIAL CLONAL HEMATOPOIESIS IMPLICATIONS

Variants seen in this gene have been reported to occur in clonal hematopoiesis (CH), an age-related process in which hematopoietic stem cells acquire somatic mutations that allow for clonal expansion¹⁵⁴⁻¹⁵⁹. CH in this gene has been associated with increased mortality, risk of coronary heart disease, risk of ischemic stroke, and risk of secondary hematologic malignancy¹⁵⁴⁻¹⁵⁵. Clinical management of patients with CH in this gene may include monitoring for hematologic changes and reduction of controllable risk factors for cardiovascular disease¹⁶⁰. Comprehensive genomic profiling of solid tumors detects nontumor alterations that are due to CH^{158,161-162}. Patient-matched peripheral blood mononuclear cell sequencing is required to conclusively determine if this alteration is present in tumor or is secondary to CH.

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CLINICAL TRIALS

IMPORTANT Clinical trials are ordered by gene and prioritized by: age range inclusion criteria for pediatric patients, proximity to ordering medical facility, later trial phase, and verification of trial information within the last two months. While every effort is made to ensure the accuracy of the information contained below, the information available in the public domain is continually updated and should be investigated by the physician or

research staff. This is not a comprehensive list of all available clinical trials. There may also be compassionate use or early access programs available, which are not listed in this report. Foundation Medicine displays a subset of trial options and ranks them in this order of descending priority: Qualification for pediatric trial → Geographical proximity → Later trial phase. Clinical trials are not ranked in order of potential or predicted efficacy for this patient or

in order of level of evidence for this patient's tumor type. Clinical trials listed here may have additional enrollment criteria that may require medical screening to determine final eligibility. For additional information about listed clinical trials or to conduct a search for additional trials, please see clinicaltrials.gov. However, clinicaltrials.gov does not list all clinical trials that might be available.

GENE

KRAS

ALTERATION

G12D

RATIONALE

Multiple clinical studies have reported lack of efficacy of MEK inhibitors as monotherapy for treatment of KRAS-mutated pancreatic cancer. Limited data suggest patients with KRAS-mutated pancreatic cancer may be sensitive to MEK-pan-RAF dual inhibitors or combination MEK/

autophagy inhibitors. Preclinical and clinical evidence suggest that KRAS G12D mutations may confer sensitivity to KRAS G12D-targeted, T-cell-receptor-based adoptive cell therapy, KRAS G12D small-molecule inhibitors, or SOS1 inhibitors.

NCT05533463

PHASE 1

Phase I Study of HRS-4642 in Patients With Advanced Solid Tumors Harboring KRAS G12D Mutation

TARGETS
KRAS

LOCATIONS: ShangHai (China)

NCT05438667

PHASE NULL

TCR-T Cell Therapy on Advanced Pancreatic Cancer

TARGETS
KRAS

LOCATIONS: Guangzhou (China)

NCT05669482

PHASE 1/2

Study of Avutemetinib (VS-6766) +Defactinib With Gemcitabine and Nab-paclitaxel in Patients With Pancreatic Cancer

TARGETS
RAFTs, MEK, FAK

LOCATIONS: Washington, California, Illinois, Missouri, Massachusetts, New York, Pennsylvania

NCT05737706

PHASE 1/2

Study of MRTX1133 in Patients With Advanced Solid Tumors Harboring a KRAS G12D Mutation

TARGETS
KRAS

LOCATIONS: Washington, Arizona, Michigan, Massachusetts, Connecticut, New York, Tennessee, Texas, Maryland, Virginia

NCT05578092

PHASE 1/2

A Phase 1/2 Study of MRTX0902 in Solid Tumors With Mutations in the KRAS MAPK Pathway

TARGETS
SOS1, KRAS

LOCATIONS: Washington, Oregon, Colorado, Ohio, Connecticut, Tennessee, Maryland, Virginia, Texas

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CLINICAL TRIALS
NCT05554367
PHASE 2

Palbociclib and Binimetinib in RAS-Mutant Cancers, A ComboMATCH Treatment Trial

TARGETS
 CDK4, CDK6, MEK

LOCATIONS: Idaho, Montana, Illinois

NCT05538130
PHASE 1

A Study to Learn About the Study Medicine Called PF-07799544 in People With Advanced Solid Tumors

TARGETS
 MEK, MAPK1, MAPK3, BRAF

LOCATIONS: Edmonton (Canada), Quebec City (Canada), Ottawa (Canada), Montreal (Canada), Montréal (Canada), Toronto (Canada), Arkansas, Ohio

NCT05518110
PHASE 2

PaTch Study: A Phase 2 Study of Trametinib and Hydroxychloroquine in Patients With Metastatic Refractory Pancreatic Cancer

TARGETS
 MEK

LOCATIONS: Dublin (Ireland)

NCT04132505
PHASE 1

Binimetinib and Hydroxychloroquine in Treating Patients With KRAS Mutant Metastatic Pancreatic Cancer

TARGETS
 MEK

LOCATIONS: Texas

NCT03825289
PHASE 1

Trametinib and Hydroxychloroquine in Treating Patients With Pancreatic Cancer

TARGETS
 MEK

LOCATIONS: Utah

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 Post-Sequencing Analysis: 150 Second St., 1st Floor, Cambridge, MA 02141 • CLIA: 22D2027531

ORDERED TEST # ORD-1794443-01

APPENDIX
Variants of Unknown Significance

NOTE One or more variants of unknown significance (VUS) were detected in this patient's tumor. These variants may not have been adequately characterized in the scientific literature at the time this report was issued, and/or the genomic context of these alterations makes their significance unclear. We choose to include them here in the event that they become clinically meaningful in the future.

APC

 NM_000038.4: c.4293G>A
 (p.M1431I)
 chr5:112175584

DDR2

 NM_006182.2: c.2163C>A
 (p.N721K)
 chr1:162746040

KMT2D (MLL2)

 NM_003482.4:
 c.5990_5991delinsTA
 (p.S1997L)
 chr12:49435990-49435991

REL

 NM_002908.2: c.33G>T
 (p.E11D)
 chr2:61118840

AR

 NM_000044.2: c.845C>A
 (p.T282N)
 chrX:66765833

EPHA3

 NM_005233.4: c.2701C>T
 (p.L901F)
 chr3:89521624

MAP3K1

 NM_005921.1:
 c.2845_2847dup
 (p.T949dup)
 chr5:56177848

ROS1

 NM_002944.2: c.6419C>G
 (p.T2140S)
 chr6:117631259

BCOR

 NM_017745.5: c.1448C>T
 (p.P483L)
 chrX:39933151

FGFR3

 NM_000142.3: c.490C>G
 (p.L164V)
 chr4:1803138

PDGFRB

 NM_002609.3: c.1108C>T
 (p.R370C)
 chr5:149512332

ZNF217

 NM_006526.2: c.2468C>T
 (p.P823L)
 chr20:52192835

DAXX

 NM_001350.4:
 c.1370_1372del (p.E457del)
 chr6:33287880-33287883

KDM5A

 NM_001042603.1: c.310A>G
 (p.T104A)
 chr12:493253

POLE

 NM_006231.2: c.3495C>G
 (p.D1165E)
 chr12:133233809

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APPENDIX

Genes assayed in FoundationOne®Liquid CDx

FoundationOne Liquid CDx interrogates 324 genes, including 309 genes with complete exonic (coding) coverage and 15 genes with only select non-coding coverage (indicated with an *); 75 genes (indicated in bold) are captured with increased sensitivity and have complete exonic (coding) coverage unless otherwise noted.

ABL1 Exons 4-9	ACVR1B	AKT1 Exon 3	AKT2	AKT3	ALK Exons 20-29, Introns 18, 19	ALOX12B	AMER1 (FAM123B or WTX)	APC
AR	ARAF Exons 4, 5, 7, 11, 13, 15, 16	ARFRP1	ARID1A	ASXL1	ATM	ATR	ATRX	AURKA
AURKB	AXIN1	AXL	BAP1	BARD1	BCL2	BCL2L1	BCL2L2	BCL6
BCOR	BCORL1	BCR* Introns 8, 13, 14	BRAF Exons 11-18, Introns 7-10	BRCA1 Introns 2, 7, 8, 12, 16, 19, 20	BRCA2 Intron 2	BRD4	BRIP1	BTG1
BTG2	BTK Exons 2, 15	CALR	CARD11	CASP8	CBFB	CBL	CCND1	CCND2
CCND3	CCNE1	CD22	CD70	CD74* Introns 6-8	CD79A	CD79B	CD274 (PD-L1)	CDC73
CDH1	CDK12	CDK4	CDK6	CDK8	CDKN1A	CDKN1B	CDKN2A	CDKN2B
CDKN2C	CEBPA	CHEK1	CHEK2	CIC	CREBBP	CRKL	CSF1R	CSF3R
CTCF	CTNNA1	CTNNB1 Exon 3	CUL3	CUL4A	CXCR4	CYP17A1	DAXX	DDR1
DDR2 Exons 5, 17, 18	DIS3	DNMT3A	DOT1L	EED	EGFR Introns 7, 15, 24-27	EMSY (C11orf30)	EP300	EPHA3
EPHB1	EPHB4	ERBB2	ERBB3 Exons 3, 6, 7, 8, 10, 12, 20, 21, 23, 24, 25	ERBB4	ERCC4	ERG	ERRF1	ESR1 Exons 4-8
ETV4* Intron 8	ETV5* Introns 6, 7	ETV6* Introns 5, 6	EWSR1* Introns 7-13	EZH2 Exons 4, 16, 17, 18	EZR* Introns 9-11	FANCA	FANCC	FANCG
FANCL	FAS	FBXW7	FGF10	FGF12	FGF14	FGF19	FGF23	FGF3
FGF4	FGF6	FGFR1 Introns 1, 5, Intron 17	FGFR2 Intron 1, Intron 17	FGFR3 Exons 7, 9 (alternative designation exon 10), 14, 18, Intron 17	FGFR4	FH	FLCN	FLT1
FLT3 Exons 14, 15, 20	FOXL2	FUBP1	GABRA6	GATA3	GATA4	GATA6	GID4 (C17orf39)	GNA11 Exons 4, 5
GNA13	GNAQ Exons 4, 5	GNAS Exons 1, 8	GRM3	GSK3B	H3-3A (H3F3A)	HDAC1	HGF	HNFI1A
HRAS Exons 2, 3	HSD3B1	ID3	IDH1 Exon 4	IDH2 Exon 4	IGF1R	IKBKE	IKZF1	INPP4B
IRF2	IRF4	IRS2	JAK1	JAK2 Exon 14	JAK3 Exons 5, 11, 12, 13, 15, 16	JUN	KDM5A	KDM5C
KDM6A	KDR	KEAP1	KEL	KIT Exons 8, 9, 11, 12, 13, 17, Intron 16	KLHL6	KMT2A (MLL) Introns 6, 8-11, Intron 7	KMT2D (MLL2)	KRAS

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LTK	LYN	MAF	MAP2K1 (MEK1) Exons 2, 3	MAP2K2 (MEK2) Exons 2-4, 6, 7	MAP2K4	MAP3K1	MAP3K13	MAPK1
MCL1	MDM2	MDM4	MED12	MEF2B	MEN1	MERTK	MET	MITF
MKNK1	MLH1	MPL Exon 10	MRE11 (MRE11A)	MSH2 Intron 5	MSH3	MSH6	MST1R	MTAP
MTOR Exons 19, 30, 39, 40, 43-45, 47, 48, 53, 56	MUTYH	MYB* Intron 14	MYC Intron 1	MYCL (MYCL1)	MYCN	MYD88 Exon 4	NBN	NF1
NF2	NFE2L2	NFKBIA	NKX2-1	NOTCH1	NOTCH2 Intron 26	NOTCH3	NPM1 Exons 4-6, 8, 10	NRAS Exons 2, 3
NSD2 (WHSC1 or MMSET)	NSD3 (WHSC1L1)	NT5C2	NTRK1 Exons 14, 15, Introns 8-11	NTRK2 Intron 12	NTRK3 Exons 16, 17	NUTM1* Intron 1	P2RY8	PALB2
PARP1	PARP2	PARP3	PAX5	PBRM1	PDCD1 (PD-1)	PDCD1LG2 (PD-L2)	PDGFRA Exons 12, 18, Introns 7, 9, 11	PDGFRB Exons 12-21, 23 9, 11
PDK1	PIK3C2B	PIK3C2G	PIK3CA Exons 2, 3, 5-8, 10, 14, 19, 21 (Coding Exons 1, 2, 4-7, 9, 13, 18, 20)	PIK3CB	PIK3R1	PIM1	PMS2	POLD1
POLE	PPARG	PPP2R1A	PPP2R2A	PRDM1	PRKAR1A	PRKCI	PRKN (PARK2)	PTCH1
PTEN	PTPN11	PTPRO	QKI	RAC1	RAD21	RAD51	RAD51B	RAD51C
RAD51D	RAD52	RAD54L	RAF1 Exons 3, 4, 6, 7, 10, 14, 15, 17, Introns 4-8	RARA Intron 2	RB1	RBM10	REL	RET Introns 7, 8, Exons 11, 13-16, Introns 9-11
RICTOR	RNF43	ROS1 Exons 31, 36-38, 40, Introns 31-35	RPTOR	RSPO2* Intron 1	SDC4* Intron 2	SDHA	SDHB	SDHC
SDHD	SETD2	SF3B1	SGK1	SLC34A2* Intron 4	SMAD2	SMAD4	SMARCA4	SMARCB1
SMO	SNCAIP	SOCS1	SOX2	SOX9	SPEN	SPOP	SRC	STAG2
STAT3	STK11	SUFU	SYK	TBX3	TEK	TENT5C (FAM46C)	TERC* ncRNA	TERT* Promoter
TET2	TGFBR2	TIPARP	TMPRSS2* Introns 1-3	TNFAIP3	TNFRSF14	TP53	TSC1	TSC2
TYRO3	U2AF1	VEGFA	VHL	WT1	XPO1	XRCC2	ZNF217	ZNF703

ADDITIONAL ASSAYS: FOR THE DETECTION OF SELECT CANCER BIOMARKERS

Microsatellite (MS) status
Blood Tumor Mutational Burden (bTMB)
ctDNA Tumor Fraction

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APPENDIX
About FoundationOne® Liquid CDx

FoundationOne Liquid CDx fulfills the requirements of the European Directive 98/79 EC for in vitro diagnostic medical devices and is registered as a CE-IVD product by Foundation Medicine's EU Authorized Representative, Qarad b.v.b.a, Ciplastraat 3, 2440 Geel, Belgium. The CE-IVD regulatory status of FoundationOne Liquid CDx is applicable in countries that accept and/or recognize the CE mark.


ABOUT FOUNDATIONONE LIQUID CDx

FoundationOne Liquid CDx was developed and its performance characteristics determined by Foundation Medicine, Inc. (Foundation Medicine). FoundationOne Liquid CDx may be used for clinical purposes and should not be regarded as purely investigational or for research only. Foundation Medicine's clinical reference laboratories are qualified to perform high-complexity clinical testing.

Please refer to technical information for performance specification details.

INTENDED USE

FoundationOne Liquid CDx is a next generation sequencing based *in vitro* diagnostic device that analyzes 324 genes. Substitutions and insertion and deletion alterations (indels) are reported in 311 genes, copy number alterations (CNAs) are reported in 310 genes, and gene rearrangements are reported in 324 genes. The test also detects the genomic signatures blood tumor mutational burden (bTMB), microsatellite instability (MSI), and ctDNA tumor fraction. FoundationOne Liquid CDx utilizes circulating cell-free DNA (cfDNA) isolated from plasma derived from the anti-coagulated peripheral whole blood of cancer patients. The test is intended to be used as a companion diagnostic to identify patients who may benefit from treatment with targeted therapies in accordance with the approved therapeutic product labeling. Additionally, FoundationOne Liquid CDx is intended to provide tumor mutation profiling to be used by qualified health care professionals in accordance with professional guidelines in oncology for patients with malignant neoplasms.

TEST PRINCIPLES

The FoundationOne Liquid CDx assay is performed exclusively as a laboratory service using circulating cell-free DNA (cfDNA) isolated from plasma derived from anti-coagulated peripheral whole blood from patients with solid malignant neoplasms. The assay employs a single DNA extraction method to obtain

cfDNA from plasma from whole blood. Extracted cfDNA undergoes whole-genome shotgun library construction and hybridization-based capture of 324 cancer-related genes including coding exons and select introns of 309 genes, as well as only select intronic regions or non-coding regions of 15 genes. Hybrid-capture selected libraries are sequenced with deep coverage using the NovaSeq® 6000 platform. Sequence data are processed using a customized analysis pipeline designed to accurately detect genomic alterations, including base substitutions, indels, select copy number variants, and select genomic rearrangements. Substitutions and insertion and deletion alterations (indels) are reported in 311 genes, copy number alterations (CNAs) are reported in 310 genes, and gene rearrangements are reported in 324 genes. The assay also reports ctDNA tumor fraction, and genomic signatures including MSI and bTMB. A subset of targeted regions in 75 genes is baited for increased sensitivity.

THE REPORT

Incorporates analyses of peer-reviewed studies and other publicly available information identified by Foundation Medicine; these analyses and information may include associations between a molecular alteration (or lack of alteration) and one or more drugs with potential clinical benefit (or potential lack of clinical benefit), including drug candidates that are being studied in clinical research. *Note:* A finding of biomarker alteration does not necessarily indicate pharmacologic effectiveness (or lack thereof) of any drug or treatment regimen; a finding of no biomarker alteration does not necessarily indicate lack of pharmacologic effectiveness (or effectiveness) of any drug or treatment regimen.

QUALIFIED ALTERATION CALLS (EQUIVOCAL)

All equivocal calls, regardless of alteration type, imply that there is adequate evidence to call the alteration with confidence. However, the repeatability of equivocal calls may be lower than non-equivocal calls.

COPY NUMBER LOSS CALLS

The FoundationOne Liquid CDx assay detects copy number loss in the following genes: *BRCA1*, *BRCA2*, and *PTEN*.

RANKING OF THERAPIES AND CLINICAL TRIALS
Ranking of Therapies in Summary Table

Therapies are ranked based on the following criteria: Therapies with clinical benefit (ranked alphabetically within each evidence category),

followed by therapies associated with resistance (when applicable).

Ranking of Clinical Trials

Pediatric trial qualification → Geographical proximity → Later trial phase.

LIMITATIONS

1. For *in vitro* diagnostic use.
2. For prescription use only. This test must be ordered by a qualified medical professional in accordance with clinical laboratory regulations.
3. A negative result does not rule out the presence of a mutation below the limits of detection of the assay. Patients for whom no companion diagnostic alterations are detected should be considered for confirmation with an appropriately validated tumor tissue test, if available.
4. The FoundationOne Liquid CDx assay does not detect heterozygous deletions.
5. The test is not intended to provide information on cancer predisposition.
6. Performance has not been validated for cfDNA input below the specified minimum input.
7. Tissue TMB and blood TMB (bTMB) are estimated from the number of synonymous and nonsynonymous single-nucleotide variants (SNVs) and insertions and deletions (indels) per area of coding genome sampled, after the removal of known and likely oncogenic driver events and germline SNPs. Tissue TMB is calculated based on variants with an allele frequency of ≥5%, and bTMB is calculated based on variants with an allele frequency of ≥0.5%.
8. ctDNA tumor fraction is the percentage of circulating tumor DNA (ctDNA) present in a cell-free DNA (cfDNA) sample. The ctDNA tumor fraction estimate integrates multiple distinct genomic features, including modeled aneuploidy and the observed allele frequencies of somatic short variants and rearrangements.
9. Microsatellite instability (MSI) is a condition of genetic hypermutability that generates excessive amounts of short insertion/deletion mutations in the tumor genome; it generally occurs at microsatellite DNA sequences and is caused by a deficiency in DNA mismatch repair (MMR) in the tumor. The MSI algorithm is based on genome wide analysis of 1765 microsatellite loci and not based on the 5 or 7 MSI loci described in current clinical practice guidelines for solid tissue testing.
10. Genomic findings from circulating cell-free DNA (cfDNA) may originate from circulating tumor DNA fragments, germline alterations, or

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APPENDIX
About FoundationOne® Liquid CDx

non-tumor somatic alterations, such as clonal hematopoiesis of indeterminate potential (CHIP). Genes with alterations that may be derived from CHIP include, but are not limited to: *ASXL1*, *ATM*, *CBL*, *CHEK2*, *DNMT3A*, *JAK2*, *KMT2D* (*MLL2*), *MPL*, *MYD88*, *SF3B1*, *TET2*, *TP53*, and *U2AF1*.

11. Alterations reported may include somatic (not inherited) or germline (inherited) alterations; however, the test does not distinguish between germline and somatic alterations. If a reported alteration is suspected to be germline, confirmatory testing should be considered in the appropriate clinical context.
12. The test is not intended to replace germline testing or to provide information about cancer predisposition.

REPORT HIGHLIGHTS

The Report Highlights includes select genomic and therapeutic information with potential impact on patient care and treatment that is specific to the genomics and tumor type of the sample analyzed. This section may highlight information including targeted therapies with potential sensitivity or resistance; evidence-matched clinical trials; and variants with potential diagnostic, prognostic, nontargeted treatment, germline, or clonal hematopoiesis implications. Information included in the Report Highlights is expected to evolve with advances in scientific and clinical research. Findings included in the Report Highlights should be considered in the context of all other information in this report and other relevant patient information. Decisions on patient care and treatment are the responsibility of the treating physician.

VARIANTS TO CONSIDER FOR FOLLOW-UP GERMLINE TESTING

The variants indicated for consideration of follow-up germline testing are 1) limited to reportable short variants with a protein effect listed in the ClinVar genomic database (Landrum et al., 2018; 29165669) as Pathogenic, Pathogenic/Likely Pathogenic, or Likely Pathogenic (by an expert panel or multiple submitters), 2) associated with hereditary cancer-predisposing disorder(s), 3) detected at an allele frequency of >30%, and 4) in select genes reported by the ESMO Precision Medicine Working Group (Mandelker et al., 2019; 31050713) to have a greater than 10% probability of germline origin if identified during tumor sequencing. The selected genes are *ATM*, *BAP1*, *BRCA1*, *BRCA2*, *BRIP1*, *CHEK2*, *FH*, *FLCN*, *MLH1*, *MSH2*, *MSH6*, *MUTYH*, *PALB2*, *PMS2*, *POLE*, *RAD51C*, *RAD51D*, *RET*, *SDHA*, *SDHB*, *SDHC*, *SDHD*,

TSC2, and *VHL*, and are not inclusive of all cancer susceptibility genes. The content in this report should not substitute for genetic counseling or follow-up germline testing, which is needed to distinguish whether a finding in this patient's tumor sequencing is germline or somatic. Interpretation should be based on clinical context.

VARIANTS THAT MAY REPRESENT CLONAL HEMATOPOIESIS

Variants that may represent clonal hematopoiesis (CH) are limited to select reportable short variants in defined genes identified in solid tumors only. Variant selection was determined based on gene tumor-suppressor or oncogene status, known role in solid tumors versus hematological malignancies, and literature prevalence. The defined genes are *ASXL1*, *ATM*, *CBL*, *CHEK2*, *DNMT3A*, *IDH2*, *JAK2*, *KMT2D* (*MLL2*), *MPL*, *MYD88*, *SF3B1*, *TET2*, and *U2AF1* and are not inclusive of all CH genes. The content in this report should not substitute for dedicated hematological workup. Comprehensive genomic profiling of solid tumors detects nontumor alterations that are due to CH. Patient-matched peripheral blood mononuclear cell sequencing is required to conclusively determine if this alteration is present in tumor or is secondary to CH. Interpretation should be based on clinical context.

NATIONAL COMPREHENSIVE CANCER NETWORK® (NCCN®) CATEGORIZATION

Biomarker and genomic findings detected may be associated with certain entries within the NCCN Drugs & Biologics Compendium® (NCCN Compendium®) (www.nccn.org). The NCCN Categories of Evidence and Consensus indicated reflect the highest possible category for a given therapy in association with each biomarker or genomic finding. Please note, however, that the accuracy and applicability of these NCCN categories within a report may be impacted by the patient's clinical history, additional biomarker information, age, and/or co-occurring alterations. For additional information on the NCCN categories, please refer to the NCCN Compendium®. Referenced with permission from the NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®). © National Comprehensive Cancer Network, Inc. 2023. All rights reserved. To view the most recent and complete version of the guidelines, go online to NCCN.org. NCCN makes no warranties of any kind whatsoever regarding their content, use or application and disclaims any responsibility for their application or use in any way.

LEVEL OF EVIDENCE NOT PROVIDED

Drugs with potential clinical benefit (or potential lack of clinical benefit) are not evaluated for source

or level of published evidence.

NO GUARANTEE OF CLINICAL BENEFIT

This report makes no promises or guarantees that a particular drug will be effective in the treatment of disease in any patient. This report also makes no promises or guarantees that a drug with potential lack of clinical benefit will in fact provide no clinical benefit.

NO GUARANTEE OF REIMBURSEMENT

Foundation Medicine makes no promises or guarantees that a healthcare provider, insurer or other third party payor, whether private or governmental, will reimburse a patient for the cost of FoundationOne Liquid CDx.

TREATMENT DECISIONS ARE THE RESPONSIBILITY OF PHYSICIAN

Drugs referenced in this Report may not be suitable for a particular patient. The selection of any, all or none of the drugs associated with potential clinical benefit (or potential lack of clinical benefit) resides entirely within the discretion of the treating physician. Indeed, the information in this Report must be considered in conjunction with all other relevant information regarding a particular patient, before the patient's treating physician recommends a course of treatment. Decisions on patient care and treatment must be based on the independent medical judgment of the treating physician, taking into consideration all applicable information concerning the patient's condition, such as patient and family history, physical examinations, information from other diagnostic tests, and patient preferences, in accordance with the standard of care in a given community. A treating physician's decisions should not be based on a single test, such as this test or the information contained in this report.

Certain sample of variant characteristics may result in reduced sensitivity. These include: low sample quality, deletions and insertions >40bp, or repetitive/high homology sequences. FoundationOne Liquid CDx is performed using cell-free DNA, and as such germline events may not be reported.

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APPENDIX

About FoundationOne®Liquid CDx

SELECT ABBREVIATIONS

ABBREVIATION	DEFINITION
CR	Complete response
DCR	Disease control rate
DNMT	DNA methyltransferase
HR	Hazard ratio
ITD	Internal tandem duplication
MMR	Mismatch repair
Muts/Mb	Mutations per megabase
NOS	Not otherwise specified
ORR	Objective response rate
OS	Overall survival
PD	Progressive disease
PFS	Progression-free survival
PR	Partial response
SD	Stable disease
TKI	Tyrosine kinase inhibitor

REFERENCE SEQUENCE INFORMATION

Sequence data is mapped to the human genome, Genome Reference Consortium Human Build 37 (GRCh37), also known as hg19.

SOFTWARE VERSION INFORMATION

MR Suite Version (RG) 7.15.0
 MR Reporting Config Version Config 49
 Analysis Pipeline Version v3.29.0
 Computational Biology Suite Version 6.29.0

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APPENDIX
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