How to Read This Report

I. Current Medications and Anticipated Drug-Gene Interactions

Lists pathway and response genes associated with all drugs currently prescribed for the patient, including the patient's response implications. Drug-drug and drug-gene interactions are also shown where applicable.

Phenotype

Poor Metabolizer	Intermediate Metabolizer	Normal Metabolizer	Rapid Metabolizer

II. Genotype and Phenotype Summary

Includes a comprehensive alphabetic listing of all pharmacogenetic variants tested, without regard to currently prescribed medications.

III. Drug-Gene Interactions by Drug Class

WARNING: The medication table contains a list of medications that are impacted by the patient's genetic profile without regard to possible drug to drug interactions. A comprehensive medication review should be performed, and the prescriber consulted prior to changing any medications.

Standard Precaution	Use Caution	Consider Alternatives
A drug with the green designation indicates that NO genetic implications of clinical relevance were found for the genes tested. Standard precautions apply for these drugs.	A drug with a yellow designation indicates that clinically relevant implications with the patient's genotype were found. The prescribing clinician should consider this information and any proposed alternatives in their treatment of the patient.	A drug with a red designation indicates that the patient's genotype has been shown to result in significantly reduced efficacy and/or increased potential for adverse reactions with the drug. The prescribing clinician should consider this information and any proposed alternatives in their treatment of the patient.

IV. Risk Phenotypes and Medications Affected

Alphabetical list of all phenotypes identified for the patient, and the medications associated with each phenotype. Variants reflecting normal expected pharmacogenetic function are excluded (see section II for the comprehensive variant listing).

V. Methodology and Disclaimer

I. Current Medications and Anticipated Drug-Gene Interactions

Current Medication	Associated Genes/Drugs	Phenotype	Interpretation
Omeprazole (Prilosec)	CYP2C19	Poor Metabolizer (*2/*2)	Metabolic Implications: Omeprazole is metabolized by CYP2C19. Based on this patient's genetic results and depending on the exact phenotype, there may be either significant risk for lack of efficacy or increased toxicity including bone weakness, and low magnesium level with standard doses.
Clopidogrel P (Plavix)	CYP2C19	Poor Metabolizer (*2/*2)	Metabolic Implications: Clopidogrel is an inactive prodrug requiring metabolism through CYP2C19 to produce its therapeutic effects. Based on this patient's genetic results, there is an increased risk of adverse cardiac and cerebrovascular events. Consider an alternative medication

Current Medications	Interpretation
• Verapamil (Calan) • Amlodipine (Norvasc, Norliqva)	As of the date of this report, there are no clinically actionable pharmacogenomic implications associated with these drugs.

Phenotype
- Poor Metabolizer
- Normal Metabolizer
- Intermediate Metabolizer
- Rapid Metabolizer

Drug
- Normal
- Caution
- Warning

Other
- * : Minor metabolic pathway
- P : Prodrug
- : Active Drug

II. Genotype and Phenotype Summary

Gene	Genotype	Phenotype	Interpretation
Cytochrome P450 Pharmacogenes and Metabolizing Pharmacogenes			
ABCB1 rs1045642	AG	Safe	Patients with this genotype may have increased concentration of efavirenz as compared to patients with the GG genotype and may have reduced concentration of efavirenz as compared to patients with the AA genotype Patients with this genotype may have decreased opioid dose requirements as compared to patients with the GG genotype, but increased opioid dose requirements as compared to patients with the AA genotype.
ABCB1 rs2032582	AC	Safe	Patients with this genotype who are treated with simvastatin may have a better reduction in total cholesterol as compared to patients with the CC genotype. Other genetic and clinical factors may also influence a patient's response to simvastatin treatment.
ABCB1 rs1128503	AG	Safe	Patients with this genotype may have decreased opioid dose requirements as compared to patients with the GG genotype, but increased opioid dose requirements as compared to patients with the AA genotype
ABCG2 rs2231142	GG	Safe	This genotype may have decreased plasma concentrations of rosuvastatin but normal myopathy risk when treated with rosuvastatin as compared to patients with the TT or GT genotype. Other genetic and clinical factors may also influence the metabolism of rosuvastatin

Gene	Genotype	Phenotype	Interpretation
ABCG2 rs2199939	CC	Safe	This genotype may have decreased plasma concentrations and response when treated with rosuvastatin as compared to patients with the CT and TT genotypes. Other genetic and clinical factors may also influence the metabolism of rosuvastatin
ABCG2 rs1481012	AA	Safe	This genotype may have decreased plasma concentrations of rosuvastatin but normal myopathy risk when treated with rosuvastatin as compared to patients with the AG and GG genotype. Other genetic and clinical factors may also influence the metabolism of rosuvastatin
CES1A1 rs71647871	CC	Caution	Patients with this genotype who are treated with clopidogrel may have increased platelet aggregation as compared to patients with the CT or TT genotypes. Other genetic and clinical factors may also influence response to clopidogrel.
COMT rs4680	AG	Caution	Patients with this genotype may have a decrease in COMT activity. This gene codes for the enzyme COMT which plays a role in the metabolism of certain neurotransmitters.
CYP1A2	*30/*30	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
CYP2A6	*40/*40	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
CYP2B6	*1/*1	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.

Gene	Genotype	Phenotype	Interpretation
CYP2C rs12777823	AA	Caution	Patients with the rs12777823 AA genotype may require a lower dose of warfarin in African Americans as compared to patients with the GG genotype. Other genetic and clinical factors may also influence warfarin dosage.
CYP2C19	*2/*2	Poor Metabolizer PM	This genotype predicts very little to no metabolic activity for the enzyme encoded by this gene. High risk for drug accumulation and adverse drug reactions. Extreme caution should be observed with prodrugs (e.g., clopidogrel). Little to no active metabolite formation is expected and a full effect of the drug may not be achievable.
CYP2C8	*1/*1	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
CYP2C9	*1/*1	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
CYP2D6 Partial Gene Deletion	-/*6	Poor Metabolizer PM	This genotype predicts very little to no metabolic activity for the enzyme encoded by this gene. High risk for drug accumulation and adverse drug reactions. Extreme caution should be observed with prodrugs (e.g., codeine). Little to no active metabolite formation is expected and a full effect of the drug may not be achievable.

Gene	Genotype	Phenotype	Interpretation
CYP3A4	*1/*1	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene. NOTE: CYP3A4 is so similar to CYP3A5 that they generally affect the same drugs. If the patient is normal for one of these genes, then you can expect the patient to metabolize these drugs normally.
CYP3A4-Independent rs4646437	GA	Caution	Patients with AG genotype may have increased dose-adjusted trough concentrations of tacrolimus as compared to patients with the AA genotype, or decreased concentrations as compared to the GG genotype. However, conflicting evidence has been reported
CYP3A5	*3C/*3C	Poor Metabolizer PM	This genotype predicts very little to no metabolic activity for the enzyme encoded by this gene. About 70%-90% of the population are estimated to be intermediate or poor metabolizer for CYP3A5 and no major consequences are expected unless a subject has reduced function for both CYP3A4 and CYP3A5 NOTE: CYP3A4 is so similar to CYP3A5 that they generally affect the same drugs. If the patient is intermediate or poor metabolizer for both of these genes, then there is increased potential for drug accumulation and adverse drug reactions. In case of prodrugs which require activation by these enzyme, this genotype may lead to lack of effectiveness
CYP3A7	*1/*1	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.

Gene	Genotype	Phenotype	Interpretation
CYP4F2	*1/*1	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
DPYD	*1/*9A	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
DPYD-Independent rs2297595	CC	Safe	Patients with the CC genotype and cancer who are treated with capecitabine, a fluoropyrimidine-based chemotherapy, may not have altered risk of drug toxicity as compared to patients with the CT or TT genotype. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence risk of drug toxicity.
DPYD-Independent rs17376848	AA	Safe	Patients with the AA genotype and cancer who are treated with capecitabine, a fluoropyrimidine-based chemotherapy, may not have altered risk of drug toxicity as compared to patients with the AG or GG genotype. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence risk of drug toxicity.
NAT2	*6/*12	Intermediate Acetylator IM	This genotype predicts reduced metabolic activity for the enzyme encoded by this gene. Increased potential for drug accumulation and adverse drug reactions. In case of prodrugs which require activation by this enzyme, this genotype may lead to lack of effectiveness

Gene	Genotype	Phenotype	Interpretation
NUDT15	*1/*1	Normal Metabolizer NM	NUDT15 normal metabolizers may be at a decreased risk of developing leukopenia or neutropenia when treated with azathioprine/ mercaptopurine as compared to patients with two no function alleles or a normal function allele in combination with an no function allele. Other genetic and clinical factors may also affect risk of developing mercaptopurine-induced leukopenia or neutropenia.
SLC6A4 rs25531	TT	Safe	Patients with this genotype may have normal serotonin transporter expression. Usual therapeutic benefit from SSRIs is associated with this genotype.
SLCO1B1	*1/*1	Normal Function NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
TPMT	*1/*2	Intermediate Metabolizer IM	This genotype predicts reduced metabolic activity for the enzyme encoded by this gene. Increased potential for drug accumulation and adverse drug reactions. In case of prodrugs which require activation by this enzyme, this genotype may lead to lack of effectiveness
UGT1A1 rs887829	CC	Safe	Patients with this genotype may have a normal risk of developing hyperbilirubinemia when treated with atazanavir or nilotinib as compared to patients with the TT genotype
UGT1A1 rs4148323	GG	Safe	Patients with this genotype may have a normal risk of developing hyperbilirubinemia when treated with atazanavir or nilotinib as compared to patients with the AG or AA genotype

Gene	Genotype	Phenotype	Interpretation
UGT1A1 rs35350960	CC	Safe	Patients with this genotype may have a normal risk of developing hyperbilirubinemia when treated with atazanavir or nilotinib as compared to patients with the AC or AA genotype
UGT1A1 rs10929302	GG	Safe	Patients with this genotype may have decreased risk of neutropenia when treated with irinotecan as compared to patients with the AA genotype. Other genetic and clinical factors may also influence irinotecan-related toxicity.
UGT1A4 rs2011425	TT	Caution	This genotype may be associated with decreased glucuronidation compared to GG and GT genotypes. Other clinical and genetic factors may affect the metabolism of tamoxifen
UGT1A6 rs17863783	GG	Safe	Patients with the GG genotype may have decreased likelihood of cardiotoxicity when exposed to anthracyclines and related substances in children with Neoplasms as compared to patients with genotype GT or TT. Other genetic and clinical factors may also influence the risk of toxicity to anthracyclines and related substances.
UGT2B15	*1/*2	Intermediate Metabolizer IM	This genotype predicts reduced metabolic activity for the enzyme encoded by this gene. Increased potential for drug accumulation and adverse drug reactions. In case of prodrugs which require activation by this enzyme, this genotype may lead to lack of effectiveness
UGT2B7	*2/*2	Normal Metabolizer NM	This genotype predicts normal metabolic activity for the enzyme encoded by this gene.
Other Pharmacogenes			

Gene	Genotype	Phenotype	Interpretation
ADRA2A rs1800544	GG	Safe	Patients with this genotype may have a better response to methylphenidate treatment as compared to patients with the CC genotype.
ADRB1 rs1801253	GC	Caution	Patients with the CG genotype may have a decreased response to beta-blockers as compared to patients with the CC genotype. However, some studies have failed to find an association. Other genetic and clinical factors may also influence a patient's response to metoprolol.
ADRB2 rs1042713	GA	Safe	Patients with this genotype and asthma may have an increased response to salmeterol as compared to patients with the AA genotype. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence a response to salmeterol.
ADRB2 rs1042714	GC	Safe	Patients with this genotype and asthma may have an increased response to salmeterol as compared to patients with the AA genotype. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence response to salmeterol.
AGTR1 rs5186	AC	Safe	Patients with this genotype and left ventricular hypertrophy may have increased response when treated with angiotensin receptor blockers as compared to patients with the AA genotype.
ALDH2 rs671	GG	Safe	Patients with this genotype may have increased risk of developing alcoholism and lower risk of hangovers as compared to patients with the AA or AG genotypes. Other genetic and clinical factors may also affect risk of developing alcoholism.

Gene	Genotype	Phenotype	Interpretation
ANKK1 rs1800497	AG	Caution	Patients with this genotype may have increased risk of side effects including hyperprolactinemia and weight gain, but decreased risk of tardive dyskinesia during treatment with antipsychotic drugs as compared to patients with the GG genotype. Other genetic and clinical factors may also influence a patient's risk for side effects.
APOB rs676210	GG	Caution	Patients with this genotype may have a smaller decreases in triglyceride levels when treated with fenofibrate as compared to patients with the AA genotype.
APOE rs7412	CC	Caution	Patients with this genotype may have decreased response to statin as compared to patients with the CT or TT genotype. Other genetic and clinical factors may also influence response to atorvastatin treatment.
ASL rs138310841	CC	Safe	This genotype is not associated with argininosuccinate synthetase (ASS1) deficiency hyperammonemia. Other genetic and clinical factors may also influence risk of the disease.
ASS1 rs121908639	GG	Safe	This genotype is not associated with argininosuccinate synthetase (ASS1) deficiency hyperammonemia. Other genetic and clinical factors may also influence risk of the disease.
ATIC rs4673993	TT	Caution	Patients with the rs4673993 TT genotype and Rheumatoid Arthritis may have decreased response when treated with methotrexate as compared to patients with the CC genotype. Other genetic and clinical factors may also influence methotrexate response.

Gene	Genotype	Phenotype	Interpretation
BCHE rs1803274	TT	Safe	Patients with this genotype have an increased risk of post anesthesia apnea when treated with succinylcholine as compared to patients with the CC genotype. Other genetic and clinical factors may also influence risk of post anesthesia apnea.
BDNF rs6265	CC	Safe	Patients with this genotype may have no increased propensity for drug absue.
C11ORF65 rs11212617	CA	Caution	Patients with this genotype may have an ncreased response to metformin as compared to patients with the AA genotype or may have a decreased response to metformin as compared to patients with the CC genotype.
CACNA1S rs1800559	CC	Safe	Patients with this genotype may have a decreased, but not absent, risk for malignant hyperthermia when treated with anesthetics as compared to patients with the TT (or AA) genotype. Other genetic or clinical factors may also influence the risk for malignant hyperthermia.
CDA rs532545	CT	Warning	Patients with this genotype who are treated with cytarabine may have increased toxicity. Other genetic and clinical factors may also influence a patient's survival when treated with cytarabine.
CFTR rs267606723	GG	Caution	Cystic fibrosis patients with this genotype (do not have a copy of the CFTR G1244E variant) have an unknown response to ivacaftor treatment, as response may depend on the presence of other CFTR variants.. Other genetic and clinical factors may also influence response to ivacaftor.

Gene	Genotype	Phenotype	Interpretation
CHRNA3/5 rs16969968	GA	Caution	Individuals with Tobacco Use Disorder carrying this genotype may have increased concentrations of cotinine, a metabolite of nicotine, as compared to individuals with the GG genotype and decreased concentrations of cottoning as compared to patients with the AA genotype. Other clinical and genetic factors may also contribute to cotinine concentrations in individuals with Tobacco Use Disorder.
CPS1 rs1047891	CC	Safe	This genotype is associated with decreased risk of hyperammonemia when treated with antiepileptics and valproic acid in people with Epilepsy as compared to genotype AA.
CPS1 rs1047883	AG	Caution	This genotype may be associated with carbamylphosphate synthetase (CPS1) deficiency hyperammonemia. Other genetic and clinical factors may also influence risk of the disease
CYB5R1 rs2232853	GG	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 1
CYB5R1 rs2232842	TT	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 1 compared to A or the C genotypes.
CYB5R2 rs11041525	TT	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 2.
CYB5R2 rs12801394	TC	Caution	This genotype may be associated with reduced function of NADH-cytochrome b5 reductase isoform 2 compared to TT genotype
CYB5R3 rs1210302322	GG	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 3

Gene	Genotype	Phenotype	Interpretation
CYB5R3 rs121965006	AA	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 3
CYB5R3 rs121965007	CC	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 3
CYB5R4 rs61382555	CC	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 4
CYB5R4 rs10080628	CC	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 4
CYB5R4 rs141290525	AA	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 4
CYB5R4 rs143478181	AA	Safe	This genotype is associated with the normal function of NADH-cytochrome b5 reductase isoform 4
DRD2 rs6277	GG	Safe	Patients with this genotype may have no increased propensity for drug abuse.
ERCC1 rs3212986	CC	Safe	Patients with this genotype may have decreased risk for nephrotoxicity with platinum-based regimens as compared to patients with the AA genotypes. Other genetic and clinical factors may also influence response to platinum-based regimens.
Factor II rs1799963	GG	Safe	Patients with this genotype may have no increased risk of prothrombin related thrombosis and may have a decreased risk for deep vein thrombosis (DVT), as compared to patients with the AA or AG genotypes.

Gene	Genotype	Phenotype	Interpretation
Factor V rs6025	CC	Safe	Patients with this genotype have normal factor V and are at no increased risk of thrombosis
FCGR3A rs396991	AA	Caution	Patients with the rs396991 AA genotype may have a decreased response to rituximab, as compared to patients with the AC or CC genotypes. Other genetic and clinical factors may also influence response to rituximab.
FUT2 rs602662	GG	Safe	Patients with this genotype may have decreased risk for vitamin B12 deficiency compared to GG genoype carriers
G6PD	*1/*Mediterranean	Variable UM	Individuals classified in the “variable” category are those (generally females) who carry one non-deficient (class IV) and one deficient (class I–III) allele
GSTP1 rs1695	AA	Caution	Patients with this genotype may have increased toxicity from fluorouracil, irinotecan or oxaliplatin chemotherapy medications.
HFE rs1799945	CC	Safe	Patients with this genotype are not a H63D hemochromatosis carrier. Patients with allele C and hemodialysis treatment require usual dose of epoetin alfa compared to carriers of allele G who require lower dose.

Gene	Genotype	Phenotype	Interpretation
HLA-A HLA-A*31:01:02	AA	Negative For HLA-A*31:01:02	Patients with this genotype (negative for HLA-A*31:01:02 allele) have low (but not absent) risk of Severe Cutaneous Adverse Reactions when treated with carbamazepine as compared to patients with positive HLA-A*31:01:02 alleles. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence risk of carbamazepine-induced adverse reactions.
HLA-B HLA-B*15:02	TT	Negative For HLA-B*15:02	Patients with this genotype (negative for HLA-B*15:02 allele) have low (but not absent) risk of Severe Cutaneous Adverse Reactions when treated with sulfamethoxazole, carbamazepine, lamotrigine, fosphenytoin, and phenytoin as compared to patients with positive HLA-B*15:02 alleles. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence risk of carbamazepine-induced adverse reactions.
HLA-B rs3909184	GG	Safe	Patients with this genotype have normal risk for carbamazepine hypersensitivity
HLA-B rs2844682	GG	Safe	Patients with this genotype may have no increased risk of ankylosing spondilitis, reactive arthritis.
HLA-B HLA-B*5801	GG	Negative For HLA-B*5801	Patients with this genotype (negative for HLA-B*58:01 allele) have low (but not absent) risk of Severe Cutaneous Adverse Reactions when treated with allopurinol as compared to patients with positive HLA-B*58:01 alleles. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence risk of allopurinol-induced adverse reactions.
HLA-B rs13202464	AA	Safe	Patients with this genotype may have no increased risk of ankylosing spondilitis, reactive arthritis.

Gene	Genotype	Phenotype	Interpretation
HLA-B rs4349859	GG	Safe	Patients with this genotype may have no increased risk of ankylosing spondilitis, reactive arthritis.
HLA-B HLA-B*5701	TG	Positive For HLA-B*5701	Patients with this genotype (positive for HLA-B*57:01) have an increased risk of hypersensitivity to abacavir and flucloxacillin as compared to patients with no HLA-B*57:01 alleles or negative for the HLA-B*57:01 test. Other genetic and clinical factors may also influence the risk of abacavir and flucloxacillin-induced adverse reactions.
HLA-B HLA-B*15:02	TT	Negative For HLA-B*15:02	Patients with this genotype (negative for HLAB*15:02 allele) have low (but not absent) risk of Severe Cutaneous Adverse Reactions when treated with sulfamethoxazole, carbamazepine, lamotrigine, fosphenytoin, and phenytoin as compared to patients with positive HLA-B*15:02 alleles. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence risk of carbamazepine-induced adverse reactions
HLA-DQA1 rs9272105	GA	Caution	This genotype may increase the risk for developing neutralizing anti-IFN-beta antibodies (i.e. increased risk of treatment failure) when patient is treated with interferon-beta therapy as compared to patients with the AA (or TT) genotype. Other genetic and clinical factors may also influence response to interferon-beta therapy.

Gene	Genotype	Phenotype	Interpretation
HPRT1 rsClin10039	AGTTAGTT	Safe	This genotype is not associated with Myfortic exacerbation leading to gout-like symptoms that could occur to patients with rare hereditary deficiency of hypoxanthine-guanine phosphoribosyl-transferase (HGPRT) such as Lesch-Nyhan and Kelley-Seegmiller syndromes. Other genetic and clinical factors may also influence Myfortic's exacerbations
HPRT1 rsClin10050	TTGTTG	Safe	This genotype is not associated with Myfortic exacerbation leading to gout-like symptoms that could occur to patients with rare hereditary deficiency of hypoxanthine-guanine phosphoribosyl-transferase (HGPRT) such as Lesch-Nyhan and Kelley-Seegmiller syndromes. Other genetic and clinical factors may also influence Myfortic's exacerbations.
HTR2A rs6311	CC	Safe	Patients with this genotype who are treated with antidepressants are less likely to experience adverse events compared to patients with the CT or TT genotype
HTR2C rs3813929	CT	Safe	Patients with this genotype who are treated with antipsychotics (especially olanzapine) may have have a decreased, but not absent, risk of weight gain as compared to patients with the CC genotype. Other genetic and clinical factors may also influence a patient's risk for weight gain with olanzapine treatment.
IFNL3 rs12979860	CT	Caution	Patients with this genotype may have a decreased response to hepatitis C treatment (peginterferon alfa-2a/2b and ribavirin) as compared to patients with the CC genotype

Gene	Genotype	Phenotype	Interpretation
IFNL3 rs8099917	TG	Caution	Patients with this genotype may have a decreased response to hepatitis C treatment (peginterferon alfa-2a/2b and ribavirin) as compared to patients with the TT genotype
IFNL4 rs11322783	CTC	Caution	Patients with the CT/T genotype and chronic hepatitis C infection may have decreased response (including reduced virological response (svr)) to pegIFN-alpha/ribavirin as compared to people with with CT/CT genotype. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence the response to pegIFN-alpha/ribavirin-based therapy.
ITPA rs7270101	AA	Safe	Patients with this genotype who are treated with azathioprine or mercaptopurine may metabolize them more slowly and have decreased incidence of adverse events compared to patients with the AC/CC genotypes. Other clinical and genetic factors may also influence likelihood of adverse events in these patients
ITPA rs1127354	CC	Caution	Patients with the rs1127354 CC genotype and chronic hepatitis C may have an increased risk of anemia as compared to patients with the AA or AC genotype when treated with peginterferon alfa-2b and ribavirin. However, conflicting evidence has been reported. Other clinical and genetic factors may influence risk of anemia when treated with peginterferon alfa-2b and ribavirin.
KIF6 rs20455	AA	Safe	Patients with this genotype may have better response to statin treatment as compared to patients with the AG or GG genotypes
LDLR rs688	CT	Safe	Patients with this genotype may have a better response to atenolol as compared to patients with genotype TT, and lower response to lovastatin compared to TT

Gene	Genotype	Phenotype	Interpretation
MTHFR rs1801131	GG	Warning	Patients with this genotype may have severely impaired MTHFR enzyme activity with increased number of complex risks. Moderate risk of anemia or drug toxicity when treated with methotrexate compared to TT genotype
NAGS rsClin1069451	CGCGGCGGCGGCGCGGCGGCGG	Safe	This genotype does not indicated that the patient has hyperammonaemia due to N-acetylglutamate synthase primary deficiency. Other genetic and clinical factors may be important for confirmation.
NAGS rsClin1069900	CC	Safe	This genotype does not indicated that the patient has hyperammonaemia due to N-acetylglutamate synthase primary deficiency. Other genetic and clinical factors may be important for confirmation.
NAGS rsClin1070557	CC	Safe	This genotype indicates that the patient has hyperammonaemia due to N-acetylglutamate synthase primary deficiency. Other genetic and clinical factors may be important for confirmation.
NOS1AP rs10494366	GT	Caution	Patients with this genotype may or may not have a risk for QTc prolongation as treatments have not shown conclusively if heterzygous (GT) individuals are affected. Other genetic and clinical factors may also influence a patient's QTc prolongation risk.
NQO1 rs1800566	GG	Safe	Patients with this genotype and Breast Neoplasms and cancer who are treated with chemotherapy regimes that include platinum compounds, anthracyclines and related substances, and nucleoside inhibitors may have a better outcome (overall survival and progression-free survival) as compared to patients with the AA genotype. However, this has been contradicted in some studies. Other genetic and clinical factors may also influence a patient's treatment outcome.

Gene	Genotype	Phenotype	Interpretation
OPRM1 rs1799971	AG	Caution	Patients with this genotype may have reduced opiate receptor expression and function. Opiates may not produce a full analgesic response. Consider non-opiate therapy for pain management. This gene encodes for the mu opioid receptor which mediates the analgesic and euphoric effects of opiates.
OTC rsClin1072591	TT	Safe	This genotype is not associated with ornithine carbamoyltransferase (OTC) deficiency hyperammonemia. Other genetic and clinical factors may also influence risk of the disease.
POLG rsClin1073559	TCTC	Safe	This genotype may have a decreased risk of hepatotoxicity in patients treated with valproic acid products as compared to patients with the TT genotype.
PROC rs1799808	CT	Safe	This genotype may require a decreased dose of warfarin as compared to patients with the CC genotype. Other genetic and clinical factors may also influence dosage of warfarin.
PROS1 rs8178607	GA	Safe	This genotype is associated with decreased time to achieve stable dose when treated with warfarin as compared to genotype GG.
RARG rs2229774	GG	Safe	Patients with the rs2229774 GG genotype may have decreased risk of anthracycline-induced cardiotoxicity in childhood cancer as compared to patients with rs2229774 AG or AA. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence the toxicity to anthracyclines.

Gene	Genotype	Phenotype	Interpretation
RYR1 rs193922770	CC	Safe	Patients with this genotype may have a decreased, but not absent, risk for malignant hyperthermia when treated with volatile anesthetics (desflurane, enflurane, halothane, isoflurane, methoxyflurane, sevoflurane) and/or succinylcholine as compared to patients with the CT or TT genotype. Other genetic or clinical factors may also influence the risk for malignant hyperthermia
RYR1 rs118192175	CC	Safe	Patients with this genotype may have a decreased, but not absent, risk for malignant hyperthermia when treated with volatile anesthetics (desflurane, enflurane, halothane, isoflurane, methoxyflurane, sevoflurane) and/or succinylcholine as compared to patients with the CT or TT genotype. Other genetic or clinical factors may also influence the risk for malignant hyperthermia
RYR1 rs118192176	GG	Safe	Patients with this genotype may have a decreased, but not absent, risk for malignant hyperthermia when treated with volatile anesthetics (desflurane, enflurane, halothane, isoflurane, methoxyflurane, sevoflurane) and/or succinylcholine as compared to patients with the AA or AG genotype. Other genetic or clinical factors may also influence the risk for malignant hyperthermia
RYR1 rs118192124	CC	Safe	Patients with this genotype may have a decreased, but not absent, risk for malignant hyperthermia when treated with volatile anesthetics (desflurane, enflurane, halothane, isoflurane, methoxyflurane, sevoflurane) and/or succinylcholine as compared to patients with the CT or TT genotype. Other genetic or clinical factors may also influence the risk for malignant hyperthermia

Gene	Genotype	Phenotype	Interpretation
RYR1 rs193922876	CC	Safe	Patients with this genotype may have a decreased, but not absent, risk for malignant hyperthermia when treated with volatile anesthetics (desflurane, enflurane, halothane, isoflurane, methoxyflurane, sevoflurane) and/or succinylcholine as compared to patients with the CT or TT genotype. Other genetic or clinical factors may also influence the risk for malignant hyperthermia
RYR1 rs118192170	TT	Safe	This variant is of uncertain significance in Malignant Hyperthermia Susceptibility. Other genetic or clinical factors may also influence the risk for malignant hyperthermia.
SCN1A rs3812718	CT	Caution	Patients with this genotype who are treated with carbamazepine may require a higher dose compared to patients with the CC genotype but a lower dose compared to patients with the TT genotype. Other genetic and clinical factors may also influence the dose of carbamazepine.
SCN2A rs2304016	AA	Caution	Patients with this genotype may have an increased risk of experiencing drug resistance when treated with antiepileptics compared to patients with the GG genotype.
SERPINC1 rs5877	TC	Safe	Patients with non-small cell lung cancer carrying this genotype may experience a decreased severity of thrombocytopenia when treated with carboplatin and gemcitabine as compared to patients with the TT genotype. Other genetic and clinical factors may also affect severity of thrombocytopenia.
SLC19A1 rs1051266	TC	Caution	Patients with this genotype and rheumatoid arthritis may have decreased response when treated with methotrexate as compared to patients with the TT genotype. However, conflicting evidence has been reported. Other genetic and clinical factors may also influence methotrexate response.

Gene	Genotype	Phenotype	Interpretation
SLC28A3 rs885004	GG	Caution	Pediatric patients with this genotype may be at an increased risk of cardiotoxicity when treated with anthracyclines compared to pediatric patients with the AA or AG genotype. Other genetic and clinical factors may also influence the development of cardiotoxicity.
SLC28A3 rs7853758	GG	Caution	Pediatric patients with this genotype may be at an increased risk of cardiotoxicity when treated with anthracyclines compared to pediatric patients with the AA or AG genotype. Other genetic and clinical factors may also influence the development of cardiotoxicity.
TNF rs1800629	GG	Safe	Patients with this genotype may have improved response to etanercept as compared to patients with the AA or AG genotype. Other genetic and clinical factors may also influence response to etanercept.
VKORC1 rs9923231	CC	Caution	Patients with this genotype have normal activity of vitamin K epoxide reductase (VKORC1).Patients with this genotype require increased warfarin dose compared to patients with the CT or TT genotype to counteract the fully functional VKORC1 enzyme
VKORC1 rs9934438	GG	Warning	Patients with this genotype require higher dose of warfarin as compared to patients with the CT or TT genotype.
VKORC1 rs2359612	GG	Caution	Patients with this genotype have normal activity of vitamin K epoxide reductase (VKORC1). Patients with this genotype require increased warfarin dose compared to patients with the AG or AA genotype to counteract the fully functional VKORC1 enzyme

Gene	Genotype	Phenotype	Interpretation
VKORC1 rs2884737	AA	Warning	Patients with this genotype have normal activity of vitamin K epoxide reductase (VKORC1). Patients with this genotype require increased warfarin dose compared to patients with the AC or CC genotype to counteract the fully functional VKORC1 enzyme.
WBP2NL rs5758550	AA	Safe	It has no proven clinical significance. Its possible significance may be due to the fact that it is located downstream of CYP2D6 and may be in high LD with rs16947 Results seem to be only valid in Native Americans
XPNPEP2 rs3788853	CA	Safe	Patients with this genotype may have decreased likelihood of angioedema when treated with ACE inhibitors as compared to patients with the AA genotype. This gene is on the X chromosome. Therefore, some individuals may have only one allele. Other genetic and clinical factors may also influence ACE inhibitor-associated angioedema.
XRCC1 rs25487	TC	Safe	Patients with this genotype may have decreased response and risk of neurotoxicity when treated with platinum-based therapies as compared to patients with the CC genotype

Phenotype
- Poor Metabolizer
- Normal Metabolizer
- Intermediate Metabolizer
- Rapid Metabolizer

Drug
- Normal
- Caution
- Warning

Other
- * : Minor metabolic pathway
- P : Prodrug
- : Active Drug

III. Drug-Gene Interactions by Drug Class

Standard Precaution	Use Caution	Consider Alternatives
Cardiovascular: Antihypertensive		
Diltiazem (Cardizem, Cardizem CD, Cardizem LA, Cartia XT, Dilacor XR, Dilt-CD, Diltia XT, Taztia XT, Tiazac, Matzim LA)	Carvedilol (Coreg) CYP2D6[PM]	
Verapamil (Calan)	Metoprolol (Lopressor) CYP2D6[PM]	
Captopril (Capoten)	Hydralazine NAT2[IM]	
Irbesartan (Avapro)	Metoprolol (Toprol XL) CYP2D6[PM]	
Nebivolol (Bystolic)		
Propranolol (Inderal)		
Amlodipine (Norvasc, Norliqva)		
Atenolol (Tenormin)		
Benazepril (Lotensin)		
Lisinopril (Prinivil, Zestril)		
Losartan [P] (Cozaar)		
Valsartan (Diovan)		
Clonidine (Catapres, Nexiclon XR)		
Olmesartan Medoxomil (Benicar)		
Cardiovascular: Anticoagulant / Antiplatelet		

Standard Precaution	Use Caution	Consider Alternatives
Rivaroxaban (Xarelto)	Warfarin (Coumadin) CYP2C9[NM], CYP4F2[NM], PROC[CT], PROS1[GA], VKORC1[CC]	Clopidogrel [P] (Plavix) CYP2C19[PM]
Acenocoumarol CYP2C9[NM], CYP4F2[NM]		Clopidogrel-Aspirin CYP2C19[PM]
Cardiovascular: Statin		
Atorvastatin (Lipitor) SLCO1B1[NM]		
Lovastatin (Mevacor) SLCO1B1[NM]		
Pravastatin (Pravachol) SLCO1B1[NM]		
Rosuvastatin (Crestor) SLCO1B1[NM], ABCG2[GG]		
Simvastatin (Zocor) SLCO1B1[NM]		
General: Antiemetic		
Promethazine (Phenergan)		Metoclopramide (Reglan) CYP2D6[PM]
Ondansetron (Zofran) CYP2D6[PM]		
General: Anticonvulsant		
Phenytoin (Dilantin, Phenytek, Dilantin Kapseal, Phenytoin Sodium Extended) CYP2C9[NM], HLA-B[TT]		
Topiramate (Topamax)		

Standard Precaution	Use Caution	Consider Alternatives
Gabapentin (Neurontin)		
General: Steroid		
Prednisone (Deltasone)		
Testosterone		
General: Proton Pump Inhibitor		
Esomeprazole (Nexium)		Lansoprazole (Prevacid) CYP2C19[PM]
		Omeprazole (Prilosec) CYP2C19[PM]
		Pantoprazole (Protonix) CYP2C19[PM]
		Rabeprazole (Aciphex) CYP2C19[PM]
		Dexlansoprazole (Dexilant) CYP2C19[PM]
General: Antidiabetic		
Pioglitazone (Actos)		
Glimepiride (Amaryl) G6PD[UM]		
Glipizide (Glucotrol) G6PD[UM]		
Glyburide (Diabeta) G6PD[UM]		
Metformin (Fortamet, Glucophage)		
General: Immunosuppressant		

Standard Precaution	Use Caution	Consider Alternatives
	Azathioprine (Azasan, Imuran) TPMT[IM], NUDT15[NM]	
General: Dopamine Agonist		
Ropinirole Hydrochloride (Requip, Requip XL)		
General: Anti-Inflammatory		
Methylprednisolone (Medrol, Solu-Medrol, A-Methapred)		
General: Antiretroviral		
peginterferon alfa-2a		
Interferon beta-1a		
Infectious Disease: Antiviral		
Acyclovir (Zovirax, Sitavig)		
peginterferon alfa-2b		
Infectious Disease: Antibiotic		
Ciprofloxacin (Cipro)		
Clarithromycin (Biaxin)		
Amoxicillin (Moxatag)		
Metronidazole (Flagyl)		
Nitrofurantoin (Macrobid, Macrodantin) G6PD[UM]*		
Infectious Disease: Antifungal		

Standard Precaution	Use Caution	Consider Alternatives
Fluconazole (Diflucan)		Voriconazole (Vfend) CYP2C19[PM]
Ketoconazole (Nizoral, Xolegel, Extina)		
mycophenolic acid (Myfortic)		
Oncology: Antineoplastic Agent		
		Methotrexate (Trexall, Otrexup, Methotrexate) ATIC[TT], MTHFR[GG], SLC19A1[TC]
Oncology: Androgen Receptor Inhibitor		
Finasteride (Proscar, Propecia)		
Pain Management: NSAID		
Celecoxib (Celebrex) CYP2C9[NM]		
Diclofenac (Voltaren)		
Meloxicam (Mobic) CYP2C9[NM]		
Naproxen (Aleve, Naprosyn)		
Pain Management: Opioid		
Fentanyl (Duragesic) CYP3A4[NM]		Codeine [P] CYP2D6[PM]
Methadone (Methadose) CYP2B6[NM]		Tramadol [P] (Ultram) CYP2D6[PM]

Standard Precaution	Use Caution	Consider Alternatives
Oxycodone Hydrochloride / Aspirin P (Percodan)		Hydrocodone / Chlorpheniramine P (Tussionex) CYP2D6[PM]
Pain Management: Muscle Relaxant		
Baclofen (Kemstro, First-Baclofen, Fleqsuvy, Gablofen)		
Carisoprodol P (Soma, Vanadom)		
Cyclobenzaprine (Amrix, Flexeril)		
Tizanidine (Zanaflex)		
Pain Management: Selective Serotonin Receptor Agonist		
Sumatriptan (Imitrex)		
Pain Management: Anesthetic Agent		
Lidocaine (Xylocaine, Lidoderm)		
Succinylcholine		
Psychiatry: Tricyclic Antidepressant		
		Amitriptyline (Endep, Elavil) CYP2D6[PM], CYP2C19[PM]
		Imipramine (Tofranil) CYP2D6[PM], CYP2C19[PM]
		Nortriptyline (Pamelor) CYP2D6[PM]
Psychiatry: Stimulant		
Lisdexamfetamine (Vyvanse)		Atomoxetine (Strattera) CYP2D6[PM]

Standard Precaution	Use Caution	Consider Alternatives
Methylphenidate (Concerta, Ritalin, Daytrana)		
Psychiatry: Antipsychotic		
Olanzapine (Zyprexa)	Risperidone (Risperdal) CYP2D6[PM]	Aripiprazole (Abilify) CYP2D6[PM]
Lurasidone (Latuda)		
Quetiapine (Seroquel) CYP3A4[NM]		
Psychiatry: Atypical Antidepressant		
Bupropion (Wellbutrin, Wellbutrin SR, Wellbutrin XL, Aplenzin)	Mirtazapine (Remeron) CYP2D6[PM]	
Trazodone (Oleptro)		
Psychiatry: Selective Serotonin Reuptake Inhibitor		
		Citalopram (Celexa) CYP2C19[PM]
		Escitalopram (Lexapro) CYP2C19[PM]
		Fluoxetine (Prozac) CYP2D6[PM]
		Paroxetine (Paxil) CYP2D6[PM]
		Sertraline (Zoloft) CYP2C19[PM], CYP2B6[NM]
Psychiatry: Antianxiety Agent		
Alprazolam (Xanax)	Diazepam (Valium) CYP2C19[PM]	

Standard Precaution	Use Caution	Consider Alternatives
Clonazepam (Klonopin)		
Lorazepam (Ativan)		
Temazepam (Restoril)		
Zolpidem (Ambien)		
Buspirone (BuSpar)		
Psychiatry: Serotonin and Norepinephrine Reuptake Inhibitor		
Duloxetine (Cymbalta)		Venlafaxine (Effexor, Effexor XR) CYP2D6[PM]
Desvenlafaxine (Pristiq)		
Urology: Vasodilator		
Sildenafil (Viagra)		
Tadalafil (Cialis)		
Vardenafil (Levitra)		
Urology: Antispasmodic		
Terazosin (Hytrin)		Tamsulosin (Flomax) CYP2D6[PM]
Doxazosin (Cardura)		Tolterodine (Detrol, Detrol LA) CYP2D6[PM]
Oxybutynin (Ditropan)		

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IV. Risk Phenotypes and Medications Affected

Gene	Info
⚠ ADRB1	This gene encodes the beta-1-adrenergic receptor (beta1AR), a G-protein-coupled adrenergic receptor that plays important roles in the regulation of the cardiac, pulmonary, vascular, endocrine and central nervous systems. Beta1-AR is the target of clinically important drugs for asthma and cardiovascular conditions including hypertension and chronic heart failure.
⚠ ANKK1	This gene encodes a protein in the Serine/Threonine family that is involved in signal transduction pathways. This gene is closely linked to the DRD2 gene (D2 subtype of the dopamine receptor)
⚠ APOB	This gene encodes a protein (apolipoprotein B) that is the main protein constituent of chylomicrons and LDL , and is the ligand for the LDL receptor. ApoB-48 and ApoB-100 are 2 isoforms of the apolipoprotein B synthesized in the gut and and the liver, respectively. Mutations in this gene or its regulatory region cause hypobetalipoproteinemia, normotriglyceridemic hypobetalipoproteinemia, and hypercholesterolemia due to ligand-defective apoB, diseases affecting plasma cholesterol and apoB levels.
⚠ APOE	This gene encodes a protein (apolipoprotein E) which is a major apoprotein of the chylomicron. It binds to a specific liver and peripheral cell receptor, and is essential for the normal catabolism of triglyceride-rich lipoprotein constituents. This apoprotein associates with lipid particles, and mainly functions in lipoprotein-mediated lipid transport between organs via the plasma and interstitial fluids. Mutations in this gene result in familial dysbetalipoproteinemia, or type III hyperlipoproteinemia (HLP III)
⚠ ATIC	The protein encoded by this gene is a bifunctional protein that catalyzes the last two steps of the de novo purine biosynthetic pathway. A mutation in this gene results in AICA-ribosiduria and Glomerulopathy With Fibronectin Deposits 2.
Medications affected by ATIC	
Methotrexate	

Gene	Info
C11orf65	This gene encodes for a protein that is involved involved in negative regulation of mitochondrial fission and negative regulation of protein targeting to mitochondrion, and is predicted to be located in cytosol and mitochondrial outer membrane.
CDA	This gene encodes for an enzyme (cytidine deaminase) involved in pyrimidine salvaging. It catalyzes the irreversible hydrolytic deamination of cytidine and deoxycytidine to uridine and deoxyuridine, respectively. It is one of several deaminases responsible for maintaining the cellular pyrimidine pool. This enzyme scavenges exogenous and endogenous cytidine and 2'-deoxycytidine for UMP synthesis.
CES1A1	This gene encodes for a member of the carboxylesterases family which is responsible for the hydrolysis or transesterification of various xenobiotics, such as cocaine and heroin, and endogenous substrates with ester, thioester, or amide bonds. They may participate in fatty acyl and cholesterol ester metabolism, and may play a role in the blood-brain barrier system. This enzyme is the major liver enzyme and functions in liver drug clearance.
CFTR	This gene encodes a member of the ATP-binding cassette (ABC) transporter superfamily. The encoded protein functions as a chloride channel, making it unique among members of this protein family, and controls ion and water secretion and absorption in epithelial tissues. Channel activation is mediated by cycles of regulatory domain phosphorylation, ATP-binding by the nucleotide-binding domains, and ATP hydrolysis. Mutations in this gene cause cystic fibrosis, the most common lethal genetic disorder in populations of Northern European descent.
Medications affected by CFTR	
Ivacaftor	
CHRNA3/5	The protein encoded by this locus encodes Cholinergic Receptor Nicotinic Alpha 3 and 5 Subunits, a ligand-gated ion channel that likely plays a role in neurotransmission. Polymorphisms in this gene have been associated with an increased risk of smoking initiation and an increased susceptibility to lung cancer.

Gene	Info
COMT	This gene encodes for Catechol-O-methyltransferase enzyme that catalyzes the transfer of a methyl group from S-adenosylmethionine to catecholamines, including the neurotransmitters dopamine, epinephrine, and norepinephrine. In addition to its role in the metabolism of endogenous substances, COMT is important in the metabolism of catechol drugs used in the treatment of hypertension, asthma, and Parkinsons disease. Diseases associated with COMT include Schizophrenia and Panic disorders
CYP2C	The human CYP2C subfamily is one of the subfamilies of the CYP2 family and it consists of four members of CYP isoforms, CYP2C8, CYP2C9, CYP2C18 and CYP2C19. CYP2C substrates include some of the most frequently prescribed drugs, such as warfarin, phenytoin, tolbutamide, glipizide, and rosiglitazone, and numerous nonsteroidal anti-inflammatory drugs such as celecoxib, flurbiprofen, ibuprofen, and diclofenac.
Medications affected by CYP2C	
Warfarin	
CYP2C19	This gene encodes for CYP2C19 enzyme, a member of the cytochrome P450 superfamily, involved in many reactions of drug metabolis. It localizes to the endoplasmic reticulum and is known to activate clopidogrel from its prodrug form to its active metabolite. In addition, it metabolizes many xenobiotics, including antidepressants, mephenytoin, omeprazole, diazepam and some barbiturates.

Medications affected by CYP2C19

Amitriptyline	Brivaracetam	Citalopram	Clobazam	Clomipramine
Clopidogrel P	Clopidogrel-Aspirin	Dexlansoprazole	Diazepam	Doxepin
Escitalopram	Flibanserin	Imipramine	Lansoprazole	Omeprazole
Pantoprazole	Rabeprazole	Sertraline	Trimipramine	Voriconazole

Gene	Info
CYP2D6	This gene encodes for CYP2D6 enzyme, a member of the cytochrome P450 superfamily, which is involved in drug metabolism. This enzyme localizes to the endoplasmic reticulum and is known to metabolize as many as 25% of commonly prescribed drugs. Its substrates include antidepressants, antipsychotics, analgesics and antitussives, beta adrenergic blocking agents, antiarrythmics and antiemetics. The gene is highly polymorphic in the human population; certain alleles result in the poor metabolizer phenotype, characterized by a decreased to null ability to metabolize the enzyme's substrates. On the other side, the gene can vary in copy number and individuals with the ultrarapid metabolizer pheotype can have 3 or more copies of the gene

Medications affected by CYP2D6

Acetaminophen w/ Codeine P	Amitriptyline	Amoxapine	Amphetamine	Aripiprazole
Atomoxetine	Brexpiprazole	Carvedilol	Cevimeline	Clomipramine
Clozapine	Codeine P	Darifenacin	Desipramine	Deutetrabenazine
Dextromethorphan/ Bupropion	Donepezil	Doxepin	Eliglustat Tartrate	Fesoterodine P
Flibanserin	Fluoxetine	Fluvoxamine	Haloperidol	Hydrocodone P
Hydrocodone / Acetaminophen P	Hydrocodone / Chlorpheniramine P	Hydrocodone / Ibuprofen P	Iloperidone	Imipramine
Lofexidine	Meclizine HCL	Metoclopramide	Metoprolol	Metoprolol
Metoprolol Succinate / Hydrochlorothiazide	Metoprolol Tartrate / Hydrochlorothiazide	Mirabegron	Mirtazapine	Nortriptyline
Oliceridine	Ondansetron	Oxycodone Hydrochloride / Acetaminophen P	Paroxetine	Perphenazine

Gene	Info			
Pimozide	Pitolisant	Propafenone	Protriptyline	Risperidone
Tamoxifen P	Tamsulosin	Tetrabenazine	Thioridazine	Tolterodine
Tramadol P	Tramadol Hydrochloride / Acetaminophen P	Trimipramine	Tropisetron	Valbenazine P
Venlafaxine	Vortioxetine			
CYP3A4_Ind	This gene encodes for CYP3A4 enzyme, a member of the cytochrome P450 superfamily, which catalyzes many reactions involved in drug metabolism. This enzyme localizes to the endoplasmic reticulum and its expression is induced by glucocorticoids and some pharmacological agents. This enzyme is involved in the metabolism of approximately half the drugs in use today, including acetaminophen, codeine, cyclosporin A, diazepam, erythromycin, and chloroquine. The enzyme also metabolizes some steroids and carcinogens.			
FCGR3A	The protein encoded by this gene (FCGR3A) is a receptor for the Fc portion of immunoglobulin G, and it is involved in the removal of antigen-antibody complexes from the circulation, as well as other responses, including antibody dependent cellular mediated cytotoxicity and antibody dependent enhancement of virus infections. Mutations in this gene are associated with immunodeficiency, and have been linked to susceptibility to recurrent viral infections, susceptibility to systemic lupus erythematosus.			
Medications affected by FCGR3A				
Rituximab				
GBA	This gene encodes a lysosomal membrane protein that cleaves the beta-glucosidic linkage of glycosylceramide, an intermediate in glycolipid metabolism. Mutations in this gene cause Gaucher disease, a lysosomal storage disease characterized by an accumulation of glucocerebrosides.			
Medications affected by GBA				
Velaglucerase Alfa				

Gene	Info			
GSTP1	This gene encodes for glutathione S-transferase 1, which plays an important role in detoxification, xenobiotic and carcinogens metabolism and neutralization.			
HLA-DQA1	This gene encodes HLA class II alpha chain paralogues. The class II molecule is a heterodimer consisting of an alpha (DQA) and a beta chain (DQB), both anchored in the membrane. It plays a central role in the immune system by presenting peptides derived from extracellular proteins. Class II molecules are expressed in antigen presenting cells (APC: B Lymphocytes, dendritic cells, macrophages). Diseases associated with HLA-DQA1 include Celiac Disease 1 and Adult-Onset Myasthenia Gravis.			
IFNL3	This gene encodes for a cytokine related to type I interferon and the IL-10 family. This cytokine has antiviral, antitumour and immunomodulatory activities. It plays a critical role in the antiviral host defense, predominantly in the epithelial tissues.			
Medications affected by IFNL3				
Boceprevir	Ribavirin	peginterferon alfa-2a	peginterferon alfa-2b	
IFNL4	This gene is a polymorphic pseudogene which, in some humans, encodes the interferon (IFN) lambda 4 protein. Diseases associated with IFNL4 include Hepatitis C Virus and Hepatitis C.			
Medications affected by IFNL4				
Boceprevir	peginterferon alfa-2a			
MTHFR	This gene encodes for methylenetetrahydrofolate reductase, an enzyme that catalyzes the conversion of 5,10-methylenetetrahydrofolate to 5-methyltetrahydrofolate. This latter is a co-substrate for homocysteine remethylation to methionine. Genetic variation in this gene influences susceptibility to occlusive vascular disease, neural tube defects, colon cancer and acute leukemia.			
Medications affected by MTHFR				
Methotrexate				

Gene	Info			
⚠ NAT2	This gene encodes for N-Acetyltransferase 2, an enzyme that functions to both activate and deactivate arylamine and hydrazine drugs and carcinogens. Polymorphisms in this gene are associated with higher incidences of cancer and drug toxicity.			
Medications affected by NAT2				
Amifampridine	Hydralazine	Isoniazid	Sulfamethoxazole	Sulfasalazine P
⚠ NOS1AP	This gene encodes a cytosolic protein that binds to the signaling molecule, neuronal nitric oxide synthase (nNOS). This complex formed with NOS1 and synapsins is necessary for specific NO and synapsin functions at a presynaptic level. It mediates an indirect interaction between NOS1 and RASD1 leading to enhance the ability of NOS1 to activate RASD1.			
⚠ OPRM1	This gene encodes for a protein known as the the mu opioid receptor (MOR). The MOR is the principal target of endogenous opioid peptides and opioid analgesic agents such as beta-endorphin and enkephalins. The MOR also has an important role in dependence to other drugs of abuse, such as nicotine, cocaine, and alcohol via its modulation of the dopamine system.			
OTC	This nuclear gene encodes a mitochondrial matrix enzyme. The encoded protein is involved in the urea cycle which functions to detoxify ammonia into urea for excretion. Mutations in this enzyme lead to ornithine transcarbamylase deficiency, which causes hyperammonemia.			
Medications affected by OTC				
Glycerol phenylbutyrate	Valproic acid			
⚠ SCN1A	This gene encodes for subunit 1 of the sodium voltage-gated channel. The transmembrane glycoprotein complex voltage-gated channel functions in the generation and propagation of action potentials in neurons and muscle. Allelic variants of this gene are associated with seizure disorders and epileptic encephalopathy disorders.			
Medications affected by SCN1A				
Carbamazepine				

Gene	Info		
⚠ SCN2A	This gene encodes for subunit 2 of the sodium voltage-gated channel. The transmembrane glycoprotein complex voltage-gated channel functions in the generation and propagation of action potentials in neurons and muscle. Allelic variants of this gene are associated with seizure disorders and autism spectrum disorder.		
⚠ SLC19A1	This gene encodes for Solute Carrier Family 19 (Folate Transporter), Member 1, a membrane protein involved in the transport of folate and in the regulation of intracellular concentrations of folate. Diseases associated with SLC19A1 include Megaloblastic Anemia, Folate-Responsive, and methotrexate pathway pharmacokinetics.		
Medications affected by SLC19A1			
Methotrexate			
⚠ SLC28A3	This gene encodes for nucleoside transporter (SLC28A3), which regulates multiple cellular processes, including neurotransmission, vascular tone, adenosine concentration in the vicinity of cell surface receptors, transport and metabolism of nucleoside drugs. SLC28A3 shows broad specificity for pyrimidine and purine nucleosides. It is involved with the transport of medications such as gemcitabine, and ribavirin.		
Medications affected by SLC28A3			
Doxorubicin			
⚠ TPMT	This gene encodes for Thiopurine S-Methyltransferase, an enzyme that metabolizes thiopurine drugs such as 6-mercaptopurine and 6-thioguanine. Genetic polymorphisms that affect this enzymatic activity are correlated with variations in sensitivity and toxicity to such drugs within individuals, by causing thiopurine S-methyltransferase deficiency.		
Medications affected by TPMT			
Azathioprine	Mercaptopurine	Thioguanine	

Gene	Info	
UGT1A4	This gene encodes a UDP-glucuronosyltransferase, an enzyme of the glucuronidation pathway that transforms small lipophilic molecules, such as steroids, bilirubin, hormones, and drugs, into water-soluble, excretable metabolites. This gene is part of a complex locus that encodes several UDP-glucuronosyltransferases	
Medications affected by UGT1A4		
Nilotinib HCl		
UGT2B15	This gene encodes for a UDP Glucuronosyl transferase, an enzyme that is invovled in the metabolism and elimination of toxic compounts, both endogenous and of xenobiotic origin. This gene also plays a role in the regulation of estrogens and androgens.	
VKORC1	This gene encodes for the catalytic subunit of the vtamin K epoxyde reductase enzyme, which is responsible for the reduction of inactive vitamin K 2,3-epoxide to active vitamin K in the endoplasmic reticulum membrane. Allelic variation in this gene is associated with vitamin k-dependent clotting factors combined deficiency of 2, and increased resistance or sensitivity to warfarin, an inhibitor of vitamin K epoxide reductase.	
Medications affected by VKORC1		
Acenocoumarol	Warfarin	

V. Methodology and Disclaimer

DecisionRx, Inc. Liability Disclaimer

This report provides suggestions based on the patient's genotype, but is in no way to be construed as a substitute for the judgment of a prescribing clinician. The information contained herein simply provides information a clinician may consider in exercising their independent medical judgment. The use of genotypes to predict drug response is not an exact science and each person's experience may differ. If any negative or potentially negative side effects are experienced by the patient, the ordering physician should consider drug discontinuation. This test has not been approved by the FDA. The laboratory producing these results is regulated under the Clinical Laboratory Improvement Act of 1988 to perform high complexity clinical testing. DecisionRx disclaims all responsibility for any adverse or potentially adverse drug reaction to an FDA-approved pharmaceutical.

Methodology and Limitations

Testing for genetic variation/mutation on listed genes was performed using PCR with allele-specific probes and/or the application refractory mutation system (ARMS). Test results are certified and accredited under CLIA regulations. These tests are intended to be used for clinical purposes. While the variant detection methods are validated, this does not rule out the possibility that this individual could be a carrier of other mutations/variations not detected by this gene mutation variation panel. Rare mutations surrounding these alleles may also affect our detection of genetic variations. Variants tested by the assay but not assigned a genotype call are reported as “No Call”. Other non-genetic and genetic factors that are not tested by these assays can affect the management and sensitivity of drugs. This genetic information shall be interpreted in conjunction with other clinical findings and history for the administration of a particular drug.

DecisionRx, Inc. will continue to routinely update its pharmacogenomic and drug knowledgebase as new information becomes available to the scientific community. Information present on any particular report reflects the content of the knowledgebase as of the date of the report only.

Laboratory Director

Rachel Beddard, M.D.

CLIA Certification Number

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