for Psychiatry and Pain Management

Full Report

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Many factors may affect the choice of optimal medication (e.g. diagnosis, environmental factors, epigenetics), hence this report is intended as a clinical decision support tool, does not constitute medical advice and does not supersede the professional judgement of the clinician. When supported by published guidelines, firm recommendations are provided and referenced, otherwise the evidence is directional in nature.

ADMINISTRATIVE DATA

Patient Name:
bio021697 patient bio021697 patient

Gender: Male
Date of birth: 2000-01-01
Phone Number: (000) 000-0000
Email: test@biron.test.com

Clinical Support
Email: pgxinfo@biron.com

Ordering Clinician
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Patient Address
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Phone: 1-866-923-9222 #8702

Sample ID: bio021697
Sample Type: saliva

Date ordered: 2022-12-05
Date of sample reception: 2022-12-05
Date of report: 2022-12-07

Fax: (514) 317-2241

HIGH RISK PHENOTYPE(S)

CYP2D6 PM.

Phenotypes: NM (Normal Metaboliser); IM (Intermediate Metaboliser); PM (Poor Metaboliser); RM (Rapid Metaboliser); UM (Ultrarapid Metaboliser); Ind (Inductible Metaboliser); NA (Normal Activity); IA (Intermediate Activity); PA (Poor Activity).

CAUTIONARY INFORMATION

Medication	Identified risk	Recommendation
Clopidogrel (Plavix®)	Reduced clopidogrel active metabolite formation; increased on-treatment platelet reactivity; increased risk for adverse cardiac and cerebrovascular events (CYP2C19 IM).	Cardiovascular indications: avoid standard dose (75mg/day) if possible; use prasugrel or ticagrelor at standard dose if no contraindication. Neurovascular: consider alternative P2Y12 inhibitor at standard dose if clinically indicated and no contraindication.[1]
Tamoxifen	Lower endoxifen concentrations compared to normal metabolizers; higher risk of breast cancer recurrence, reduced probability of event-free and recurrence-free survival (CYP2D6 PM).	Recommend alternative hormonal therapy such as an aromatase inhibitor for post-menopausal women or aromatase inhibitor along with ovarian function suppression in premenopausal women. Note, higher dose tamoxifen (40mg/day) increases but does not normalize endoxifen concentrations and can be considered if aromatase inhibitors are contraindicated.[2]

PGx RECOMMENDATIONS - PSYCHIATRY

↑ Dose increase may be required due to lower exposure to active metabolite(s).

↓ Dose reduction may be required due to higher exposure to active metabolite(s).

~ Exposure is difficult to predict, insufficient data to calculate dose adjustments.

✓ Genetic results predict an increased likelihood of better response.

! Increased risk of poorer response and/or adverse drug reactions. Close monitoring recommended.

✗ Medication not recommended by peer-reviewed guidelines.

Genetic Associations identified

Medications	Exposure	Efficacy	Adverse Drug Reactions
Antidepressants			
Monoamine oxidase inhibitors (MAOs)			
Phenelzine (Nardil®)	no marker available	no marker available	no marker available
Tranylcypromine (Parnate®)	no marker available	no marker available	no marker available
Moclobemide (Manerix®)	↓ Consider using a lower dose (CYP2D6 PM, CYP2C19 IM).[3]	no marker available	no marker available
Other antidepressants			
Trazodone (Desyrel®)	Normal exposure	no marker available	no marker available
Vilazodone (Viibryd®)	ABCB1 - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Bupropion (Wellbutrin®)	↓ CYP2B6 IM, POR - Consider using a lower dose.	Normal efficacy	no marker available
Mirtazapine (Remeron®)	↓ Consider using a lower dose (CYP2D6 PM).	Normal efficacy	no marker available
Vortioxetine (Trintellix®)	↓ CYP2D6 PM - Consider reducing the starting dose, a maximum dose of 10mg/day and reduce the dose by 50% with concomitant CYP2D6 inhibitor.[4]	no marker available	no marker available
Esketamine (Spravato®)	↓ CYP2B6 IM, POR - Consider using a lower dose.	Normal efficacy	! Increased risk of hypertension (SLC6A2).
Ketamine (Ketalar®)	↓ CYP2B6 IM, POR - Consider using a lower dose.	Normal efficacy	! Increased risk of hypertension (SLC6A2).
Selective serotonin reuptake inhibitors (SSRIs)			
Fluvoxamine (Luvox®)	↓ CYP2D6 PM - Consider reducing the starting dose by 25-50% and titrate to response, or consider an alternative drug not predominantly metabolized by CYP2D6.[5]	✓ Increased likelihood of a better response (GRIK4).	no marker available
Fluoxetine (Prozac®)	! CYP2D6 PM - Monitor more closely for side effects, or consider an alternative drug not predominantly metabolized by CYP2D6.[5]	✓ Increased likelihood of a better response (GRIK4).	no marker available
Sertraline (Zoloft®)	CYP2C19 IM, ABCB1 - Initiate therapy with recommended starting dose; a low dose may be adequate.	✓ Increased likelihood of a better response (GRIK4).	! Increased risk of SSRI-induced sexual side effects (HTR2A, SLC6A4).
Citalopram (Celexa®)	↓ CYP2C19 IM - Do not exceed the following daily doses: 15mg for adults up to 65 yrs; 7.5mg for adults 65 yrs or older.[6]	✓ Increased likelihood of a better response (GRIK4).	! Increased risk of SSRI-induced sexual side effects (HTR2A, SLC6A4).

Genetic Associations identified

Medications	Exposure	Efficacy	Adverse Drug Reactions
Escitalopram (Cipralex®)	↓ CYP2C19 IM - Do not exceed the following daily doses: 15mg for adults up to 65 yrs; 7.5mg for adults 65 yrs or older.[6]	✓ Increased likelihood of a better response (GRIK4).	! Increased risk of SSRI-induced sexual side effects (HTR2A, SLC6A4).
Paroxetine (Paxil®)	✗ CYP2D6 PM - Consider an alternative drug not predominantly metabolized by CYP2D6, or consider reducing the starting dose by 50% and titrate to response.[5]	✓ Increased likelihood of a better response (GRIK4).	no marker available
Serotonin–norepinephrine reuptake inhibitors (SNRIs)			
Desvenlafaxine (Pristiq®)	Normal exposure	✓ Increased likelihood of a better response (GRIK4).	no marker available
Levomilnacipran (Fetzima®)	Initiate with recommended dose; a low dose may be adequate (ABCB1).	✓ Increased likelihood of a better response (GRIK4).	no marker available
Duloxetine (Cymbalta®)	↓ Consider using a lower dose (CYP2D6 PM).	! Close monitoring of response recommended (GRIK4, DRD3).	no marker available
Venlafaxine (Effexor XR®)	✗ Consider an alternative drug not predominantly metabolized by CYP2D6, or consider reducing the starting dose and closely monitor response and tolerance (CYP2D6 PM).[7]	✓ Increased likelihood of a better response (GRIK4).	no marker available
Tricyclic antidepressants (TCAs)			
Amitriptyline (Elavil®)	✗ CYP2C19 IM, CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Clomipramine (Anafranil®)	✗ CYP2C19 IM, CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Desipramine (Norpramin®)	✗ CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Doxepin (Sinequan®)	✗ CYP2C19 IM, CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Imipramine (Tofranil®)	✗ CYP2C19 IM, CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Nortriptyline (Aventyl®)	✗ CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Trimipramine (Surmontil®)	✗ CYP2C19 IM, CYP2D6 PM - Avoid tricyclic use, or consider a 50% reduction of the recommended starting dose.[8]	Normal efficacy	no marker available
Antipsychotics			
1st generation antipsychotics			
Loxapine (Loxapac®)	Normal exposure	no marker available	no marker available
Trifluoperazine (Stelazine®)	Normal exposure	no marker available	no marker available

Genetic Associations identified			
Medications	Exposure	Efficacy	Adverse Drug Reactions
Chlorpromazine (Largactil®)	↓ CYP2D6 PM - Consider using a lower dose.	no marker available	no marker available
Fluphenazine (Moditen®)	↓ CYP2D6 PM - Consider using a lower dose.	no marker available	no marker available
Haloperidol (Haldol®)	↓ CYP2D6 PM - Reduce the starting dose by 50% and titrate based on response and tolerance, or consider an alternative drug not predominantly metabolized by CYP2D6, such as flupentixol, fluphenazine, quetiapine, olanzapine or clozapine.[7]	no marker available	Normal risks
Perphenazine (Trilafon®)	↓ CYP2D6 PM - Consider reducing the starting dose.	no marker available	no marker available
Pimozide (Orap®)	↓ CYP2D6 PM - Consider reducing the starting dose and do not exceed 50% of the maximum standard dose (i.e., adults: 4mg/day, children: 0.05mg/kg/day to a maximum of 2mg/day). Doses should not be increased earlier then 14 days.[7,9]	no marker available	no marker available
Zuclopenthixol (Clopixol®)	↓ CYP2D6 PM - Consider reducing the starting dose by 50%, or consider using an alternative drug not predominantly metabolized by CYP2D6, such as flupentixol, fluphenazine, quetiapine, olanzapine or clozapine.[7]	no marker available	no marker available
2nd generation antipsychotics			
Asenapine (Saphris®)	Normal exposure	no marker available	no marker available
Cariprazine (Vraylar®)	Normal exposure	no marker available	no marker available
Lurasidone (Latuda®)	Normal exposure	no marker available	no marker available
Paliperidone (Invega®)	ABCB1 - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Quetiapine (Seroquel®)	ABCB1 - Initiate with recommended dose; a low dose may be adequate.	no marker available	Normal risks
Ziprasidone (Zeldox®)	Normal exposure	no marker available	no marker available
Aripiprazole (Abilify®)	↓ CYP2D6 PM - Consider reducing the standard dose by 50% and do not exceed 10 mg/day or 300 mg/month (68-75% of the standard maximum dose); maximum should be 200 mg/month with concomitant CYP3A4 inhibitor.[10,7]	Normal efficacy	no marker available
Brexpiprazole (Rexulti®)	↓ CYP2D6 PM - Consider reducing the standard dose by 50%; consider reducing the dose by 75% with concomitant CYP3A4 inhibitor.[11,7]	no marker available	no marker available
Olanzapine (Zyprexa®)	Normal exposure	no marker available	! Increased risk for antipsychotic-induced weight gain (DRD2).
Clozapine (Clozaril®)	↓ CYP2D6 PM - Consider using a lower dose.	no marker available	! Increased risk for antipsychotic-induced weight gain (DRD2).

Genetic Associations identified

Medications	Exposure	Efficacy	Adverse Drug Reactions
Risperidone (Risperdal®)	CYP2D6 PM - Consider reducing the starting dose by 33%. If problematic side effects originating in the central nervous system occur, consider reducing the dose to 50% of the standard dose.[7]	Normal efficacy	Increased risk for antipsychotic-induced weight gain (DRD2).
Anxiolytics			
Bromazepam (Lectopam®)	Normal exposure	no marker available	no marker available
Buspirone (Buspar®)	Normal exposure	no marker available	no marker available
Chlordiazepoxide (Librium®)	UGT2B15 IM - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Clobazam (Frisium®)	CYP2C19 IM - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Clonazepam (Rivotril®)	Normal exposure	no marker available	no marker available
Clorazepate (Tranxene®)	UGT2B15 IM - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Diazepam (Valium®)	Normal exposure	no marker available	no marker available
Flurazepam (Dalmane®)	Normal exposure	no marker available	no marker available
Lorazepam (Ativan®)	UGT2B15 IM - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Nitrazepam (Mogadon®)	Normal exposure	no marker available	no marker available
Oxazepam (Serax®)	UGT2B15 IM - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Temazepam (Restoril®)	UGT2B15 IM - Initiate with recommended dose; a low dose may be adequate.	no marker available	no marker available
Zolpidem (Sublinox®)	Normal exposure	no marker available	no marker available
Alprazolam (Xanax®)	CYP3A5 IM - Initiate therapy with recommended starting dose, but may require a higher dose.	no marker available	no marker available
Hydroxyzine (Atarax®)	CYP3A5 IM - Initiate therapy with recommended starting dose, but may require a higher dose.	no marker available	no marker available
Midazolam (Versed®)	CYP2C19 IM, CYP3A5 IM - Initiate with recommended dose but monitor response and tolerance more closely; insufficient data to calculate dose adjustments.	no marker available	no marker available
Central alpha-adrenergic agonists			
Guanfacine (Intuniv XR®)	Normal exposure	no marker available	no marker available
Clonidine (Catapres®)	CYP2D6 PM - Consider using a lower dose.	Normal efficacy	no marker available
Mood Stabilizers			
Gabapentin (Neurontin®)	Normal exposure	no marker available	no marker available
Lamotrigine (Lamictal®)	Normal exposure	no marker available	Normal risks
Levetiracetam (Keppra®)	Normal exposure	no marker available	no marker available

Genetic Associations identified			
Medications	Exposure	Efficacy	Adverse Drug Reactions
Oxcarbazepine (Trileptal®)	Normal exposure	no marker available	Normal risks
Phenytoin (Dilantin®)	Normal exposure	no marker available	Normal risks
Pregabalin (Lyrica®)	no marker available	no marker available	no marker available
Topiramate (Topamax®)	no marker available	Normal efficacy	no marker available
Carbamazepine (Tegretol®)	↑ CYP3A5 IM - Initiate with recommended dose but may require a higher dose.	no marker available	Normal risks
Lithium (Carbolith®)	no marker available	! Increased likelihood of a poorer response (CACNG2) yet lower likelihood of with if lithium therapy is successful for bipolar disorder (lncRNA).	no marker available
Valproic acid, Divalproex (Depakene®, Epival®)	Normal exposure	no marker available	! Increased risk of weight gain (ANKK1).
Norepinephrine Reuptake Inhibitor			
Atomoxetine (Strattera®)	↓ CYP2D6 PM - Children: Initiate with a dose of 0.5mg/kg/day and if no clinical response and in the absence of adverse events after 2 weeks, consider a gradual dose increase. If unacceptable side effects are present at any time, consider a reduction in dose. Adults: Initiate with a dose of 40mg/day and if no clinical response and in the absence of adverse events after 2 weeks increase dose gradually to 80mg/day. If response is inadequate after 2 weeks, consider a dose increase. If unacceptable side effects are present at any time, consider a reduction in dose.[12,7]	no marker available	no marker available
Psychostimulants			
Amphetamine / Dextroamphetamine (Adderall XR®)	↓ CYP2D6 PM - Consider using a lower dose.	no marker available	no marker available
Dextroamphetamine (Dexedrine®)	↓ CYP2D6 PM - Consider using a lower dose.	no marker available	no marker available
Lisdexamfetamine (Vyvanse®)	↓ CYP2D6 PM - Consider using a lower dose.	no marker available	no marker available
Methylphenidate (Ritalin®, Concerta®, Biphentin®, Foquest®)	Normal exposure	! Close monitoring of response recommended, especially with prenatal smoking exposure (ADRA2A, COMT Val/Val, SLC6A2, TH).	no marker available

PGx RECOMMENDATIONS - PAIN MANAGEMENT

Dose increase may be required due to lower exposure to active metabolite(s).

Dose reduction may be required due to higher exposure to active metabolite(s).

Exposure is difficult to predict, insufficient data to calculate dose adjustments.

Genetic results predict an increased likelihood of better response.

Increased risk of poorer response and/or adverse drug reactions. Close monitoring recommended.

Medication not recommended by peer-reviewed guidelines.

Genetic Associations identified			
Medications	Exposure	Efficacy	Adverse Drug Reactions
Analgesic			
Acetaminophen (Tylenol®)	no marker available	no marker available	no marker available
Antimetabolite			
Methotrexate	Normal exposure	no marker available	no marker available
Cannabinoids			
Cannabidiol (CBD)	Normal exposure	no marker available	no marker available
Nabilone (Cesamet®)	no marker available	no marker available	no marker available
Tetrahydrocannabinol (THC)	Normal exposure	no marker available	Normal risks
Muscle Relaxant			
Carisoprodol (Soma®)	CYP2C19 IM - Initiate therapy with recommended starting dose and use with caution; a low dose may be adequate.	no marker available	no marker available
Cyclobenzaprine (Flexeril®)	Normal exposure	no marker available	no marker available
Methocarbamol (Robaxin®)	no marker available	no marker available	no marker available
Tizanidine (Zanaflex®)	Normal exposure	no marker available	no marker available
Nonsteroidal Anti-Inflammatory Drugs (NSAID)			
Acetylsalicylic acid (Aspirin®)	no marker available	no marker available	no marker available
Celecoxib (Celebrex®)	Normal exposure	no marker available	no marker available
Diclofenac (Voltaren®)	Normal exposure	no marker available	no marker available
Etodolac (Ultradol®)	Normal exposure	no marker available	no marker available
Flurbiprofen (Ansaid®)	Normal exposure	no marker available	no marker available
Ibuprofen (Advil®)	Normal exposure	no marker available	no marker available
Indomethacin (Indocid®)	Normal exposure	no marker available	no marker available
Ketorolac (Toradol®)	Normal exposure	no marker available	no marker available
Meloxicam (Mobicox®)	Normal exposure	no marker available	no marker available

Genetic Associations identified			
Medications	Exposure	Efficacy	Adverse Drug Reactions
Nabumetone (Relafen®)	Normal exposure	no marker available	no marker available
Naproxen (Naprosyn®)	no marker available	no marker available	no marker available
Piroxicam (Feldene®)	Normal exposure	no marker available	no marker available
Tenoxicam (Mobiflex®)	Normal exposure	no marker available	no marker available
Opioid antagonists			
Naloxone (Narcan®)	no marker available	Normal efficacy	no marker available
Naltrexone (Revia®)	no marker available	Normal efficacy	no marker available
Opioids			
Buprenorphine (Butrans®)	Normal exposure	no marker available	no marker available
Butorphanol (Stadol®)	no marker available	no marker available	no marker available
Hydromorphone (Dilaudid®)	no marker available	Normal efficacy	no marker available
Meperidine (Demerol®)	Normal exposure	no marker available	no marker available
Nalbuphine (Nubain®)	no marker available	no marker available	no marker available
Remifentanil (Ultiva®)	no marker available	no marker available	no marker available
Sufentanil (Sufenta®)	Normal exposure	no marker available	no marker available
Tapentadol (Nucynta®)	no marker available	no marker available	no marker available
Fentanyl (Duragesic®)	↑ CYP3A5 IM - Initiate with recommended dose but may require a higher dose.	no marker available	no marker available
Oxycodone (Supeudol®)	↑ CYP2D6 PM - Initiate therapy with recommended starting dose but monitor response more closely due to reduced oxymorphone formation; may require a dose increase.	Normal efficacy	no marker available
Methadone	↓ CYP2B6 IM, POR - Consider using a lower dose.	no marker available	no marker available
Hydrocodone (Hycodan®)	! CYP2D6 PM - Initiate with recommended dose but monitor response more closely because of possibility of diminished analgesia due to reduced hydromorphone formation. If no response and opioid use is warranted, consider non-codeine or non-tramadol opioid.[13]	Normal efficacy	no marker available
Morphine	Normal exposure	Normal efficacy	! Increased risk of gastrointestinal side effects (FAAH).
Codeine	✗ CYP2D6 PM - Avoid using codeine because of possibility of diminished analgesia due to greatly reduced morphine formation. If opioid use is warranted, avoid tramadol.[13,14]	Normal efficacy	no marker available

Genetic Associations identified

Medications	Exposure	Efficacy	Adverse Drug Reactions
Tramadol (Ultram®)	✖ CYP2D6 PM - Avoid using tramadol because of possibility of diminished analgesia. If opioid use is warranted, avoid codeine.[13,14]	Normal efficacy	no marker available

PGx RECOMMENDATIONS - COMPLEMENTARY TREATMENTS

- Dose increase may be required due to lower exposure to active metabolite(s).
- Dose reduction may be required due to higher exposure to active metabolite(s).
- Exposure is difficult to predict, insufficient data to calculate dose adjustments.
- ✓ Genetic results predict an increased likelihood of better response.
- ! Increased risk of poorer response and/or adverse drug reactions. Close monitoring recommended.
- ✗ Medication not recommended by peer-reviewed guidelines.

Genetic Associations identified			
Medications	Exposure	Efficacy	Adverse Drug Reactions
Antiemetics			
Dimenhydrinate (Gravol®)	no marker available	no marker available	no marker available
Odansetron (Zofran®)	CYP2D6 PM - Initiate therapy with recommended starting dose; a low dose may be adequate.	no marker available	no marker available
Granisetron (Kytril®)	CYP3A5 IM - Initiate therapy with recommended starting dose but may require a higher dose.	no marker available	no marker available
Palonosetron (Aloxi®)	CYP2D6 PM - Consider using a lower dose.	no marker available	no marker available
Proton pump inhibitors (PPI)			
Esomeprazole (Nexium®)	no marker available	no marker available	no marker available
Dexlansoprazole (Dexilant®)	CYP2C19 IM - Initiate therapy with standard dose but for chronic therapy (> 12 weeks) and efficacy achieved, consider reducing the daily dose by 50% and monitor for continued efficacy.[15]	no marker available	no marker available
Lansoprazole (Prevacid®)	CYP2C19 IM - Initiate therapy with standard dose but for chronic therapy (> 12 weeks) and efficacy achieved, consider reducing the daily dose by 50% and monitor for continued efficacy.[15]	no marker available	no marker available
Omeprazole (Losec®)	CYP2C19 IM - Initiate therapy with standard dose but for chronic therapy (> 12 weeks) and efficacy achieved, consider reducing the daily dose by 50% and monitor for continued efficacy.[15]	no marker available	no marker available
Pantoprazole (Pantoloc®)	CYP2C19 IM - Initiate therapy with standard dose but for chronic therapy (> 12 weeks) and efficacy achieved, consider reducing the daily dose by 50% and monitor for continued efficacy.[15]	no marker available	no marker available
Sedative-Hypnotics			
Diphenydramine (Benadryl®)	no marker available	no marker available	no marker available
Eszopiclone (Lunesta®)	Normal exposure	no marker available	no marker available
Melatonin	no marker available	no marker available	no marker available
Zopiclone (Imovane®)	Normal exposure	no marker available	no marker available

Genetic Associations identified			
Medications	Exposure	Efficacy	Adverse Drug Reactions
Lemborexant (Dayvigo®)	CYP3A5 IM - Initiate therapy with recommended starting dose but may require a higher dose.	no marker available	no marker available
Wakefulness-promoting agent			
Modafinil (Alertec®)	Normal exposure	no marker available	no marker available

PGx ASSOCIATIONS - EXPOSURE

METABOLISM

The level of activity of the enzymes listed below influence total exposure to active metabolite(s).

	CYP450	POR	CES	UGT
Variant(s) detected / tested	4/8	1/1	0/1	2/4

Enzymes	Phenotype	Genotype	Details
	PM IM **NM** RM UM		
CYTOCHROME P450 (CYP450)			
CYP2D6		*4/*4	**Poor metabolizer (PM)** Total loss of CYP2D6 function.
CYP2B6		*1/*6 or *4/*9	**Intermediate metabolizer (IM)** Reduced CYP2B6 activity compared to normal metabolizers.
CYP2C19		*1/*2	**Intermediate metabolizer (IM)** Reduced CYP2C19 activity compared to normal metabolizers.
CYP3A5		*1/*3	**Intermediate metabolizer (IM)** Increased CYP3A5 activity compared to the most common phenotype (i.e., poor metabolizers).
CYP1A2		*1A/*1A	**Normal metabolizer (NM)** Normal CYP1A2 activity.
CYP2A6		*1/*1	**Normal metabolizer (NM)** Normal CYP2A6 activity.
CYP2C9		*1/*1	**Normal metabolizer (NM)** Normal CYP2C9 activity.

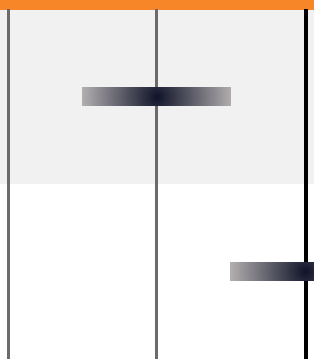
Enzymes	Phenotype	Genotype	Details
	PM IM **NM** RM UM		
CYP3A4		*1/*1	**Normal metabolizer (NM)** Normal CYP3A4 activity.
Carboxylesterase-1 (CES) and Cytochrome P450 Oxidoreductase (POR)			
POR		A/G	**Intermediate activity (IA)** Reduced POR activity compared to normal phenotypes (POR participates in CYP2B6 activation).
CES1		C/C	**Normal metabolizer (NM)** Normal CES1 activity.
UDP-GLUCURONOSYLTRANSFERASES (UGT)			
UGT1A4		*1/*3	**Intermediate metabolizer (IM)** Reduced UGT1A4 activity compared to normal metabolizers.
UGT2B15		*1/*2	**Intermediate metabolizer (IM)** Reduced UGT2B15 activity compared to normal metabolizers.
UGT1A1		*1/*1	**Normal metabolizer (NM)** Normal UGT1A1 activity.
UGT2B7		*1/*1	**Normal metabolizer (NM)** Normal UGT2B7 activity.

PGx ASSOCIATIONS - EXPOSURE

DISTRIBUTION

The efflux pumps listed below influence exposure to medications at the site of action (e.g. central nervous system)

	ABCB1	ABCG2
Variant(s) detected / tested	1/1	0/1

Efflux Pump	Phenotype	Genotype	Details
	Poor activity / Intermediate activity / **Normal activity**		
EFFLUX PUMPS (P-GLYCOPROTEIN, MULTIDRUG RESISTANCE PROTEIN)			
ABCB1		GCC/GCT	**Intermediate activity (IA)** Reduced efflux pump activity may result in higher substrate concentrations, increasing the likelihood of response but also increasing the risk of adverse drug reactions.
ABCG2		G/G	**Normal activity (NA)** Normal efflux pump activity may result in normal or lower concentrations of substrates at the site of action.

PGx ASSOCIATIONS - EFFICACY

	The variants listed below have been associated variability in drug response. When detected, they are with a higher likelihood of better or worse response to medications.	
	Better response more likely	**Poorer response more likely**
Variant(s) detected/tested	7/17	3/7

Better response more likely

Gene	Reference	Variant detected	Associated medication(s)
ADRA2A	rs1800544	yes	methylphenidate
COMT	rs4680	yes	venlafaxine (AA), methylphenidate (GG)
GRIK4	rs1954787	yes	citalopram, desvenlafaxine, duloxetine, escitalopram, fluoxetine, fluvoxamine, levomilnacipran, paroxetine, sertraline, venlafaxine
lncRNA	rs74795342	yes	lithium
lncRNA	rs75222709	yes	lithium
SLC6A2	rs28386840	yes	methylphenidate
SLC6A2	rs5569	yes	methylphenidate
ANKK1	rs1800497	no	aripiprazole, risperidone, naltrexone
BDNF	rs6265	no	citalopram, escitalopram, sertraline, fluoxetine, fluvoxamine, paroxetine
FKBP5	rs4713916	no	citalopram, desvenlafaxine, duloxetine, escitalopram, levomilnacipran, sertraline, fluoxetine, fluvoxamine, mirtazapine, paroxetine, venlafaxine
GNB3	rs5443	no	clonidine
HTR2A	rs2770296	no	bupropion
HTR2A	rs6311	no	citalopram, escitalopram, fluoxetine, fluvoxamine, paroxetine
HTR7	rs7905446	no	citalopram, escitalopram, sertraline, fluoxetine, fluvoxamine, paroxetine
OPRM1	rs1799971	no	naloxone
SLC6A2	rs2242446	no	venlafaxine
TPH2	rs1487278	no	amitriptyline, clomipramine, desipramine, doxepin, imipramine, mirtazapine, nortriptyline, trimipramine

Poorer response more likely

Gene	Reference	Variant detected	Associated medication(s)
CACNG2	rs2283967	yes	lithium
DRD3	rs963468	yes	duloxetine
TH	rs2070762	yes	methylphenidate
ANKK1	rs1800497	no	bupropion
BDNF	rs6265	no	esketamine
GRIK1	rs2832407	no	topiramate
OPRM1	rs1799971	no	codeine, hydrocodone, hydromorphone, morphine, tramadol

PGx ASSOCIATIONS - ADVERSE DRUG REACTIONS

	The variants tested below have been associated with a higher likelihood of specific adverse drug reactions to medication(s)
	Increased risk of adverse drug reactions
Increased risk of adverse drug reactions	4/15

Increased risk of adverse drug reactions

Gene	Reference	Variant detected	Associated medication(s)
ANKK1	rs1800497	yes	weight gain: valproic acid
DRD2	rs6275	yes	antipsychotic-induced weight gain: clozapine, olanzapine, risperidone
FAAH	rs324420	yes	gastrointestinal side effects (nausea, vomiting): morphine (A allele); cannabis use disorder: THC (AA)
SLC6A2	rs28386840	yes	hypertension: esketamine
ADRA2A	rs1800544	no	antipsychotic-induced weight gain: clozapine, olanzapine, risperidone
CNR1	rs806380	no	cannabis use disorder: THC
GNB3	rs5443	no	antipsychotic-induced weight gain: clozapine, olanzapine, risperidone
HLA-A	*31:01	no	cutaneous adverse reactions: carbamazepine
HLA-B	*15:02	no	cutaneous adverse reactions: carbamazepine, oxcarbazepine, phenytoin
HTR2A	rs6311	no	gastrointestinal side effects (nausea, vomiting): citalopram, escitalopram, sertraline
HTR2C	rs3813929	no	antipsychotic-induced weight gain: clozapine, olanzapine, risperidone
INSIG2	rs17047764	no	antipsychotic-induced weight gain: clozapine, olanzapine, risperidone
MC4R	rs489693	no	antipsychotic-induced weight gain: clozapine, olanzapine, quetiapine, risperidone
MC4R	rs17782313	no	antipsychotic-induced weight gain: quetiapine
SLC6A5	rs2298826	no	extrapyramidal side effects: haloperidol

ANALYTICAL RESULTS

The following analytical results were used to generate the pharmacogenomic interpretations found in this report. Technical limitations inherent with the methods used to produce these results may hinder the attribution of a definitive phenotype (see technical limitations)

Gene	Variant Details (GRCh38.p12)		Result
ABCB1	rs1045642	chr7:87509329	G|G
	rs2032582	chr7:87531302	C|C
	rs2032583	chr7:87531245	C|T
ABCG2	rs2231142	chr4:88131171	G|G
ADRA2A	rs1800544	chr10:111076745	C|G
ANKK1	rs1800497	chr11:113400106	G|G
BDNF	rs6265	chr11:27658369	C|C
CACNG2	rs2283967	chr22:36567486	C|T
CES1	rs71647871	chr16:55823658	C|C
CNR1	rs806380	chr6:88154934	A|G
COMT	rs4680	chr22:19963748	G|G
CYP1A2	rs762551	chr15:74749576	C|C
	rs2069514	chr15:74745879	G|G
CYP2A6	rs1801272	chr19:40848628	A|A
	rs5031017	chr19:40843845	Undetermined
	rs28399433	chr19:40850474	A|A
CYP2B6	rs2279343	chr19:41009358	G|A
	rs3745274	chr19:41006936	G|T
	rs28399499	chr19:41012316	T|T
CYP2C9	rs1057910	chr10:94981296	A|A
	rs1799853	chr10:94942290	C|C
	rs7900194	chr10:94942309	G|G
	rs9332131	chr10:94949282-94949283	A|A
	rs9332239	chr10:94989020	C|C
	rs28371685	chr10:94981224	C|C
	rs28371686	chr10:94981301	C|C
	rs72558187	chr10:94941958	T|T
	rs72558190	chr10:94947782	C|C
CYP2C19	rs4244285	chr10:94781859	G|A
	rs4986893	chr10:94780653	G|G
	rs6413438	chr10:94781858	C|C
	rs12248560	chr10:94761900	C|C
	rs12769205	chr10:94775367	G|A
	rs17884712	chr10:94775489	G|G
	rs28399504	chr10:94762706	A|A
	rs41291556	chr10:94775416	T|T
	rs56337013	chr10:94852738	C|C
	rs72552267	chr10:94775453	G|G
	rs72558186	chr10:94781999	T|T
CYP2D6	rs16947	chr22:42127941	G|G
	rs1065852	chr22:42130692	A|A
	rs1135840	chr22:42126611	G|G
	rs3892097	chr22:42128945	T|T
	rs5030655	chr22:42129084	A|A
	rs5030656	chr22:42128174-42128178	A|A
	rs5030862	chr22:42130668	C|C
	rs5030865	chr22:42129033	C|C
	rs5030867	chr22:42127856	T|T
	rs28371725	chr22:42127803	C|C
	rs28371706	chr22:42129770	G|G
	rs35742686	chr22:42128242	T|T
	rs59421388	chr22:42127608	C|C
	rs72549354	chr22:42128815-42128817	D|D
	rs201377835	chr22:42129910	C|C
	Gene Deletion	n/a	Not Detected
	Gene Duplication	n/a	Not Detected

Gene	Variant Details (GRCh38.p12)		Result
CYP3A4	rs4986907	chr7:99769804	C|C
	rs35599367	chr7:99768693	G|G
	rs55785340	chr7:99768360	A|A
	rs67666821	chr7:99758184-99758188	D|D
	rs72552799	chr7:99770165	C|C
CYP3A5	rs776746	chr7:99672916	C|T
	rs10264272	chr7:99665212	C|C
	rs28365083	chr7:99652613	G|G
	rs28383479	chr7:99660516	C|C
	rs41303343	chr7:99652771	D|D
	rs55817950	chr7:99676198	G|G
	rs56411402	chr7:99665237	T|T
DRD2	rs6275	chr11:113412755	A|A
DRD3	rs963468	chr3:114144040	G|G
FAAH	rs324420	chr1:46405089	A|C
FKBP5	rs4713916	chr6:35702206	G|G
GNB3	rs5443	chr12:6845711	C|C
GRIK1	rs2832407	chr21:29595188	C|C
GRIK4	rs1954787	chr11:120792654	C|C
*HLA-A*31:01*	rs1061235	chr6:29945521	A|A
*HLA-B*15:02*	rs144012689	chr6:31355003	T|T
HTR2A	rs6311	chr13:46897343	T|T
	rs6313	chr13:46895805	A|A
	rs2770296	chr13:46866425	T|T
HTR2C	rs3813929	chrX:114584047	C|T
HTR7	rs7905446	chr10:90859404	G|T
INSIG2	rs17047764	chr2:118111006	C|G
long non-coding (lnc) RNA	rs74795342	chr21:18954018	A|G
	rs75222709	chr21:18955109	G|T
MC4R	rs489693	chr18:60215554	C|C
	rs17782313	chr18:60183864	T|T
MTHFR	rs1801131	chr1:11794419	T|T
	rs1801133	chr1:11796321	G|G
OPRM1	rs1799971	chr6:154039662	A|A
POR	rs2868177	chr7:75960585	A|G
SLC6A2	rs5569	chr16:55697923	G|G
	rs2242446	chr16:55656513	C|T
	rs28386840	chr16:55652906	A|T
SLC6A4	5-HTTLPR	chr17:30190154-30240133	S|L
SLC6A5	rs2298826	chr11:20638211	G|G
TH	rs2070762	chr11:2165105	G|G
TPH2	rs1487278	chr12:72007071	T|T
UGT1A1	rs4148323	chr2:233760498	G|G
	rs34815109	chr2:233760234-233760248	6|6
UGT1A4	rs2011425	chr2:233718962	G|T
UGT2B7	rs7439366	chr4:69098620	T|T
UGT2B15	rs1902023	chr4:68670366	C|A

TEST METHODOLOGY AND LIMITATIONS

Nucleic acid amplification techniques may be subject to general interference by factors such as reaction inhibitors and low quality or quantity of extracted DNA. Factors influencing the amount and quality of extracted DNA include but are not limited to patient oral hygiene, collection technique and presence of dietary or microbial source of nucleic acids and nuclease. When present, these interferents typically yield no result rather than an inaccurate one. Risk of suboptimal DNA quantity or quality is significantly reduced by automated DNA extraction which uses chemistry without PCR inhibitors (magnetic beads) and systematic dilution, quantitation and normalization of DNA before nucleic acid amplification. Very infrequent variants or polymorphisms occurring in primer-binding regions may also affect testing and could produce an erroneous result or assay failure. The test does not detect all known and unknown variations in the genes tested, nor does absence of a detectable variant (typically reported as *1 for metabolic enzymes) rule out the presence of other, non-detected variants. The test detects CYP2D6 deletion and duplication but cannot identify hybrid alleles nor differentiate duplication in the presence of deletion. CYP2D6 deletion and duplication assays can translate into equivocal phenotype results where a range of enzyme activity level must be reported. Test results and clinical interpretation may be inaccurate for individuals who have undergone or are receiving non-autologous blood transfusions, tissue, and/or organ transplant therapies.

DISCLAIMER

Biron Health Group developed this pharmacogenomic report. This test does not diagnose any disorder, condition or disease. The interpretations and recommendations provided in this report are intended as a clinical support tool (DST) to be used solely by a healthcare professional. Commercial names are indicated as examples and do not consist an exhaustive list.

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For the full list of references, contact pgxinfo@biron.com

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