EasyDNA

PERSONALISED MEDICATION

Pharmacogenomic Report

ABOUT THIS REPORT

This report provides clinically relevant information on what the patient's genetic results predict about their response to a number of medications covered by this report.

The information concerns drug metabolism and plasma concentrations (drug exposure), as well as the potential for altered clinical effects.

Based on the available information found in the published literature, each medication has been assigned a category according to the likely clinical significance of each gene-drug interaction.
The three categories are:

MAJOR PRESCRIBING CONSIDERATIONS

A potentially significant effect on drug response is predicted. There may be guidelines or a drug label recommending consideration be given to a change in the dose, the medication type, or further monitoring in order to minimize the risk of the potential clinical issue noted.
Of note, "Major" prescribing considerations do not always preclude the use of a specific medication or necessitate a dosage change if the drug is currently effective and well tolerated, this will be dependent on the individual gene-drug interaction and the clinical circumstances.

MINOR PRESCRIBING CONSIDERATIONS

Altered drug response is possible, but either the clinical significances is thought to be minor or there is currently limited evidence available. Consider monitoring for any potential clinical effects annotated in this report. There are generally no specific recommendations to alter dosage or medication according to current guidelines.

USUAL PRESCRIBING CONSIDERATIONS

Genetic results are not predicted to have a significant effect on drug response, based on the literature currently available, and there are no additional prescribing considerations. Other factors may still influence drug response and therefore usual monitoring for adverse effects and efficacy still applies.

Medications which have a prescribing consideration to use an alternative medication will be annotated with this symbol ⚠. Consult the personalized prescribing considerations section of the report for the detailed recommendations.

PHARMACOGENOMIC GUIDELINES

For many medications covered in this report, evidence-based guidelines and drug label information are available and where relevant are referenced in this report.
Key practice guidelines include:

1. Clinical Pharmacogenetics Implementation Consortium (CPIC)
2. The Royal Dutch Pharmacists Association – Pharmacogenetics Working Group (DPWG).
3. The FDA Table of Pharmacogenetic Associations and drug label information

REPORT BREAKDOWN

The report consists of the following 6 sections:

1. Medications of Interest (if provided)- presents summarized and detailed prescribing considerations for medications of interest based on the pharmacogenomic test results.
2. Personalized Medication Guide - provides a list of all medications covered by the test categorized as having major, minor or usual prescribing considerations.
3. Genetic test results summary – presents the patients genotypes for the genes relevant to the medications covered by this report.
4. Medication tables arranged according to the three categories of MAJOR, MINOR or USUAL prescribing considerations.
5. Details of genetic test results – provides an explanation of genotype results and the predicted effect on drug exposure and drug response.
6. References – list of key peer-reviewed literature that has been used to produce the report.

MEDICATIONS OF INTEREST SUMMARY

MEDICATION	GENE(S)	PRESCRIBING CONSIDERATIONS
ATORVASTATIN CALCIUM	SLCO1B1	**Adverse effects**
CODEINE PHOSPHATE	CYP2D6 OPRM1	**Reduced / inadequate response**
IBUPROFEN	CYP2C9	**Adverse effects**

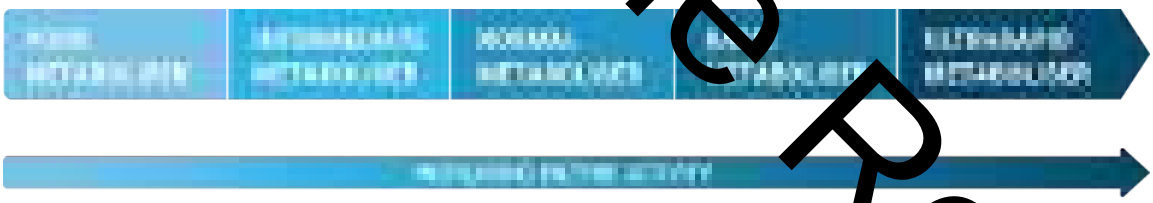
MEDICATIONS WITH NO PRESCRIBING CONSIDERATIONS BASED ON myDNA TEST

ALPRAZOLAM, CANDESARTAN CILEXETIL, METFORMIN HYDROCHLORIDE, PARACETAMOL

PHARMACOGENOMIC TEST RESULTS SUMMARY

GENE	GENOTYPE	PREDICTED PHENOTYPE
CYP1A2	*1F/*1F	**Ultrarapid metaboliser (with inducer present)**
CYP2C19	*1/*1	**Normal metaboliser**
CYP2C9	*1/*3	**Intermediate metaboliser**
CYP2D6	*4/*4	**Poor metaboliser**
CYP3A4	*1/*22	**Intermediate metaboliser**
CYP3A5	*1/*3	**Intermediate metaboliser**
OPRM1	[illegible]	**Lower opioid sensitivity**
SLCO1B1	*1/[illegible]	**Decreased transporter function**
VKORC1	GG	**Normal VKORC1 enzyme level**

Detailed interpretations of genetic test results are provided at the end of this report.



MEDICATIONS OF INTEREST EXPANDED

MEDICATION	INTERPRETATION	RECOMMENDATION
ATORVASTATIN CALCIUM	**SLCO1B1 - Decreased transporter function:** This SLCO1B1 genotype is associated with increased atorvastatin exposure compared with a normal function genotype, which may translate to increased risk of atorvastatin related myopathy.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	Based on this SLCO1B1 genotype, CPIC guidelines[1] provide a moderate recommendation to prescribe less than or equal to 40 mg as a starting dose and adjust doses based on disease-specific guidelines. Be aware of possible increased risk for myopathy especially for the 40 mg dose. If doses >40mg are needed for desired efficacy, consider combination therapy (i.e. atorvastatin plus non-statin guideline directed medical therapy). Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Atorvastatin 80mg - High SAMS risk If used < 1 year: Consider changing to a statin/dose combination with lower SAMS risk. If used > 1 year without SAMS: it is reasonable to continue. Atorvastatin 40mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue. Atorvastatin 10-20mg - Low SAMS risk.
CODEINE PHOSPHATE	**CYP2D6 - Poor metaboliser** **OPRM1 - Lower opioid sensitivity:** Greatly reduced metabolism of codeine into its active metabolite morphine. There is a high likelihood of an inadequate analgesic response to codeine.[2] Whilst this OPRM1 genotype has been associated with reduced sensitivity to morphine and by extrapolation, to codeine as well, there is insufficient evidence for its clinical significance.	Based on the CYP2D6 genotype CPIC[3] provides a strong recommendation to avoid codeine use because of possibility of diminished analgesia. If opioid use is warranted, consider a non-tramadol opioid. There is no additional genotype-guided dosing recommendation based on the OPRM1 result.
IBUPROFEN	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism by CYP2C9 and increased drug exposure are predicted[4]. This has been associated with an increased risk of adverse effects, including gastrointestinal bleeding[4].	CPIC guidelines[5] have a moderate recommendation to initiate therapy with the lowest recommended starting dose. Titrate upward to clinical effect or maximum recommended dose with caution. In accordance with prescribing information, use the lowest effective dose for the shortest duration required. Carefully monitor for adverse effects such as blood pressure and kidney function. Consider general measures to manage the risk of toxicity such as considering alternative treatments, using the lowest effective dose and gastroprotective agents as clinically appropriate.

PERSONALIZED MEDICATION GUIDE

Each medication below has been categorized as having major, minor or usual prescribing considerations based on the pharmacogenomic test results. NOTE: These classifications and recommendations do not account for the effect of any inhibitors or inducers. The table is not an all-inclusive list of medications but includes many commonly prescribed medications.

Legend

Consider alternative medication ⚠ | Major prescribing consideration | Minor prescribing consideration | Usual prescribing consideration

CLASS	MAJOR	MINOR	USUAL
ADHD - miscellaneous agents	Atomoxetine		
Angiotensin receptor blockers		Irbesartan Losartan	
Antianginals	Perhexiline		
Antiarrhythmics	Flecainide		
Anticholinergics (genitourinary)	Tolterodine	Darifenacin	
Anticholinesterases		Donepezil Galantamine	
Anticoagulants			Prasugrel Ticagrelor
Antidepressants - other	Vortioxetine	Agomelatine Mianserin Mirtazapine	Moclobemide
Antidepressants - SNRIs	Venlafaxine ⚠	Duloxetine	
Antidepressants - SSRIs	Fluoxetine Fluvoxamine ⚠ Paroxetine ⚠		Citalopram Escitalopram Sertraline
Antidepressants - TCAs	Amitriptyline ⚠ Clomipramine ⚠ Dothiepin ⚠ Doxepin ⚠ Imipramine ⚠ Nortriptyline ⚠		
Antidiabetics		Glibenclamide Gliclazide Glimepiride Glipizide	Tolbutamide
Antiemetics	Metoclopramide Ondansetron Tropisetron		

CLASS	MAJOR	MINOR	USUAL
Antiepileptics	Fosphenytoin Phenytoin		
Antifungals - Azoles			Voriconazole
Antihistamines		Chlorpheniramine Dexchlorpheniramine Promethazine	
Antiplatelet drugs			Clopidogrel
Antipsychotics	Aripiprazole Brexpiprazole Haloperidol Risperidone Flupenthixol ⚠	Chlorpromazine Clozapine Olanzapine Quetiapine	Flupenthixol
Antitussives	Dextromethorphan		
Benzodiazepines			Clobazam Diazepam
Beta blockers	Metoprolol Timolol	Carvedilol Propranolol	Nebivolol
Calcineurin inhibitors	Tacrolimus		
Drugs for alcohol dependence			Naltrexone
Drugs for sexual dysfunction	Dapoxetine ⚠		
Hypnotics			Melatonin
Immunomodulators and antineoplastics	Tamoxifen ⚠	Gefitinib	
Miscellaneous	Eliglustat Tamsulosin	Atazanavir	Cyclophosphamide Proguanil
Neurological drugs	Siponimod Tetrabenazine		
NSAIDs	Celecoxib Ibuprofen Meloxicam Piroxicam ⚠	Mefenamic Acid	Diclofenac Indomethacin
Opioid Analgesics	Codeine ⚠ Tramadol ⚠	Oxycodone	Morphine
Proton pump inhibitors		Lansoprazole Omeprazole Pantoprazole	Esomeprazole Rabeprazole

CLASS	MAJOR	MINOR	USUAL
Psychostimulants		Dexamphetamine Lisdexamfetamine	
Statins	Atorvastatin Fluvastatin Lovastatin ⚠ Pitavastatin Simvastatin ⚠	Pravastatin Rosuvastatin	

PERSONALIZED PRESCRIBING CONSIDERATIONS

The following tables outline personalized recommendations for future medications.
These tables do not account for the effect of any inhibitors or inducers. The table is not an all-inclusive list of medications but includes many commonly prescribed medications

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
ATOMOXETINE ADHD - miscellaneous agents	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism by CYP2D6 and greatly increased drug exposure is predicted. An increased risk of some side effects has been shown for this genotype (e.g. increased blood pressure and heart rate, QT interval prolongation, dry mouth, erectile dysfunction and insomnia) but also greater improvement of ADHD symptoms as compared to non-poor metabolisers in those who tolerate treatment. This genotype is associated with lower final dose requirement.	CPIC[6] provides a strong recommendation for children and moderate recommendation for adults for dosing of atomoxetine. Refer to CPIC guidelines for details. In summary, Adults: initiate at 40 mg/day. If no clinical response and no adverse events after 2 weeks, increase dose to 80 mg/day. If inadequate response after 2 weeks, consider use of plasma concentrations 2-4 hours after dosing to guide titration. Children: initiate at 0.5mg/kg/day. If no clinical response and no adverse events after 2 weeks, consider use of plasma concentrations 4 hours after dosing to guide titration. Note: FDA-approved drug label[7] recommends maximum doses of 1.4mg/kg/day in children up to 70kg and 100 mg daily in adults or children over 70kg. Note: dosing recommendations should be considered with other clinical factors by the treating clinician(s). For CYP2D6 poor metabolisers or patients on strong CYP2D6 inhibitors, FDA approved labelling[7] advises using a reduced dosing strategy (starting dose 0.5mg/kg/day, and only increasing to 1.2mg/kg/day after 4 weeks if required) in children and adolescent patients with body weight <70kg. For children and adolescents >70kg, and for adults, atomoxetine should be initiated at 40mg/day and only increased to 80mg/day after four weeks if necessary.
PERHEXILINE Antianginals	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism and increased perhexiline exposure are predicted. There is an increased risk of concentration-dependent adverse effects (hepatotoxicity and peripheral neuropathy), especially if appropriate dose reduction and therapeutic drug monitoring do not occur.	Expect prolonged time to reach steady-state. Early therapeutic drug monitoring is required when perhexiline is used. A greatly reduced maintenance dose requirement is expected. In addition to adjusting dose according to concentration, the CPNDS[8] notes that poor metabolisers may require doses as low as 50 mg once a week.
FLECAINIDE Antiarrhythmics	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	The DPWG guidelines[9] suggest reducing the dose to 50% of the standard dose, recording an ECG and monitoring the plasma concentration.
TOLTERODINE Anticholinergics (genitourinary)	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects. Concomitant use with CYP3A4 inhibiting drugs may be expected to further increase tolterodine exposure and the risk of adverse effects.	No genotype-guided dosing recommendation available. Monitor for adverse effects. The FDA[10] has cautioned regarding this genotype and increased risk for QT prolongation with tolterodine.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
VORTIOXETINE Antidepressants - other	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and increased drug exposure is predicted. This may be associated with an increased risk of concentration-dependent adverse effects.	The TGA approved Product Information[11] states that a dose adjustment is not required. The FDA[12] approved labelling states that the recommended maximum dose is 10mg for CYP2D6 poor metabolisers. Regardless of which dosing advice is followed, be alert for adverse effects.
VENLAFAXINE Antidepressants - SNRIs ⚠	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism of venlafaxine into O-desvenlafaxine (also an active drug) is predicted. This will result in increased venlafaxine exposure and reduced O-desvenlafaxine exposure. There may be an increased risk of adverse effects, such as gastrointestinal discomfort. There are indications that the effectiveness of venlafaxine is reduced when used for management of depression in patients with this genotype.	The DPWG[13] recommends: It is not possible to offer adequately substantiated advice for dose reduction based on the literature. 1. Choose an alternative. 2. If an alternative is not an option and side effects occur: a) Reduce the dose b) Check the plasma concentrations of venlafaxine and O-desmethylvenlafaxine (this is not routinely available for venlafaxine). It is not known whether it is possible to reduce the dose to such an extent that effectiveness is maintained without side effects. In general, it is assumed that the effectiveness is determined by the sum of the plasma concentrations of venlafaxine and O-desmethylvenlafaxine. However, the side effects do not appear to be related to this sum.
FLUOXETINE Antidepressants - SSRIs	**CYP2D6 - Poor metaboliser** **CYP2C9 - Intermediate metaboliser:** The metabolism of fluoxetine is complex due to the involvement of several CYP enzymes (especially CYP2D6 and CYP2C9), the formation of active metabolites and the enzyme inhibiting effect of the parent drug and metabolites (especially on CYP2D6). The CYP2D6 genotype predicts increased fluoxetine exposure and reduced formation of the active S-norfluoxetine metabolite. The CYP2C9 genotype predicts reduced metabolism via this pathway. There may be an increased risk of adverse effects.	Based on the CYP2D6 genotype, DPWG[14] recommends that no specific action on fluoxetine dosing is required for this genotype. Monitor for altered clinical effect, including adverse effects. The FDA[15] has cautioned regarding this genotype and increased risk for QT prolongation with fluoxetine. If adverse effects are a concern, consider an alternative antidepressant for which normal metabolism is predicted.
FLUVOXAMINE Antidepressants - SSRIs ⚠	**CYP2D6 - Poor metaboliser** **CYP1A2 - Ultrarapid metaboliser (with inducer present):** Fluvoxamine is metabolised by both CYP2D6 (predominant pathway) and CYP1A2. Negligible metabolism by CYP2D6 and increased metabolism by CYP1A2 in the presence of enzyme inducers such as cigarette smoke are predicted. Note that fluvoxamine itself will inhibit CYP1A2, which could negate the effect of enzyme induction, especially with increasing dose. Fluvoxamine exposure is likely to be increased. There is some evidence that increased drug exposure is associated with adverse effects, such as gastrointestinal upset.	Based on the CYP2D6 genotype, CPIC[16] provides an optional recommendation to consider a 25-50% reduction of the recommended starting dose and titrate to response. Alternatively, CPIC recommends using an alternative drug not metabolised by CYP2D6. DPWG [17] suggests no specific action on fluvoxamine dosing is required based on this CYP2D6 genotype.
PAROXETINE Antidepressants - SSRIs ⚠	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism by CYP2D6 and greatly increased drug exposure are predicted. There may be increased adverse effects.	CPIC[16] guidelines provide an optional recommendation to select an alternative drug not predominantly metabolised by CYP2D6. If using paroxetine, consider a 50% reduction of the recommended starting dose and titrate to response. It would also be reasonable to monitor for adverse effects.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
AMITRIPTYLINE Antidepressants - TCAs	**CYP2D6 - Poor metaboliser** **CYP2C19 - Normal metaboliser:** Amitriptyline is metabolised by CYP2C19 into an active metabolite, which is further metabolised by CYP2D6 into an inactive metabolite. Normal metabolism of amitriptyline and negligible metabolism (via CYP2D6) of the active metabolite are predicted. Higher plasma concentrations of the active metabolite may increase the risk of adverse effects.	For use at higher doses such as in the treatment of depression, CPIC[18] provides a strong recommendation to avoid amitriptyline use and consider use of an alternative not metabolised by CYP2D6. If a tricyclic is required, consider 50% reduction of the recommended steady-state starting dose. Consider therapeutic drug monitoring to guide dose adjustments. For use at lower doses such as in treatment of neuropathic pain, initial dose adjustments are not recommended but close monitoring for adverse effects is advisable.
CLOMIPRAMINE Antidepressants - TCAs	**CYP2D6 - Poor metaboliser** **CYP2C19 - Normal metaboliser:** Clomipramine is metabolised by CYP2C19 into an active metabolite, which is further metabolised by CYP2D6 into an inactive metabolite. Normal metabolism of clomipramine and negligible metabolism (via CYP2D6) of the active metabolite are predicted. Higher plasma concentrations of the active metabolite may increase the risk of adverse effects.	CPIC[18] provides an optional recommendation to avoid clomipramine use and consider use of an alternative not metabolised by CYP2D6. If a tricyclic is required, consider 50% reduction of the recommended steady-state starting dose. Consider therapeutic drug monitoring to guide dose adjustments. Note that these recommendations only apply to higher initial doses of tricyclic antidepressants for treatment of conditions such as depression.
DOTHIEPIN Antidepressants - TCAs	**CYP2D6 - Poor metaboliser** **CYP2C19 - Normal metaboliser:** Dothiepin is metabolised by CYP2C19 into an active metabolite, which is further metabolised by CYP2D6 into an inactive metabolite. Normal metabolism of dothiepin and negligible metabolism (via CYP2D6) of the active metabolite are predicted. Higher plasma concentrations of the active metabolite may increase the risk of adverse effects.	CPIC[18] provides an optional recommendation to avoid dothiepin use and consider use of an alternative not metabolised by CYP2D6. If a tricyclic is required, consider 50% reduction of the recommended steady-state starting dose. Consider therapeutic drug monitoring to guide dose adjustments. Note that these recommendations only apply to higher initial doses of tricyclic antidepressants for treatment of conditions such as depression.
DOXEPIN Antidepressants - TCAs	**CYP2D6 - Poor metaboliser** **CYP2C19 - Normal metaboliser:** Doxepin is metabolised by CYP2C19 into an active metabolite, which is further metabolised by CYP2D6 into an inactive metabolite. Normal metabolism of doxepin and negligible metabolism (via CYP2D6) of the active metabolite are predicted. Higher plasma concentrations of the active metabolite may increase the risk of adverse effects.	CPIC[18] provides an optional recommendation to avoid doxepin use and consider use of an alternative not metabolised by CYP2D6. If a tricyclic is required, consider 50% reduction of the recommended steady-state starting dose. Consider therapeutic drug monitoring to guide dose adjustments. Note that these recommendations only apply to higher initial doses of tricyclic antidepressants for treatment of conditions such as depression.
IMIPRAMINE Antidepressants - TCAs	**CYP2D6 - Poor metaboliser** **CYP2C19 - Normal metaboliser:** Imipramine is metabolised by CYP2C19 into an active metabolite, which is further metabolised by CYP2D6 into an inactive metabolite. Normal metabolism of imipramine and negligible metabolism (via CYP2D6) of the active metabolite are predicted. Higher plasma concentrations of the active metabolite may increase the risk of adverse effects.	CPIC[18] provides an optional recommendation to avoid imipramine use and consider use of an alternative not metabolised by CYP2D6. If a tricyclic is required, consider 50% reduction of the recommended steady-state starting dose. Consider therapeutic drug monitoring to guide dose adjustments. Note that these recommendations only apply to higher initial doses of tricyclic antidepressants for treatment of conditions such as depression.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
NORTRIPTYLINE Antidepressants - TCAs ⚠	**CYP2D6 - Poor metaboliser:** Greatly reduced nortriptyline metabolism and increased drug exposure are predicted. An increased risk of adverse effects is expected.	For use at higher doses such as in the treatment of depression, CPIC guidelines[18] provide a strong recommendation to avoid nortriptyline and consider an alternative antidepressant not metabolised by CYP2D6. If prescribing nortriptyline, CPIC guidelines recommend a 50% reduction of the recommended steady-state starting dose, as well as using therapeutic drug monitoring to guide dose adjustments. For use at lower doses such as in treatment of neuropathic pain, initial dose adjustments are not recommended but close monitoring for adverse effects is advisable.
METOCLOPRAMIDE Antiemetics	**CYP2D6 - Poor metaboliser:** Reduced metabolism of metoclopramide by CYP2D6 is predicted. There may be an increased risk of extrapyramidal adverse effects, particularly at higher doses.	The FDA-approved drug label[19] suggests a dose reduction in poor metabolisers. The suggested dose for use in gastrointestinal reflux is 5 mg four times daily or 10 mg three times daily; the suggested dose for use in diabetic gastroparesis is 5 mg four times daily. Monitor for adverse effects.
ONDANSETRON Antiemetics	**CYP2D6 - Poor metaboliser:** Negligible metabolism via CYP2D6 and increased drug exposure are predicted. This has been associated with an improved antiemetic response. It may also increase the risk of concentration-dependent adverse effects.	CPIC[20] notes that there is insufficient evidence for the clinical impact based on this CYP2D6 genotype. The usual starting dose is suggested. It would be advisable to monitor for adverse effects, especially with the use of higher doses.
TROPISETRON Antiemetics	**CYP2D6 - Poor metaboliser:** Significantly reduced metabolism via CYP2D6 and increased drug exposure are predicted. This has been associated with an improved antiemetic response. It may also increase the risk of concentration-dependent adverse effects.	CPIC[20] notes that there is insufficient evidence for the clinical impact based on this CYP2D6 genotype. The usual starting dose is suggested. It would be advisable to monitor for adverse effects, especially with the use of higher doses.
FOSPHENYTOIN Antiepileptics	**CYP2C9 - Intermediate metaboliser:** Fosphenytoin is a prodrug of phenytoin. Reduced phenytoin metabolism and increased drug exposure are predicted. This genotype has been associated with an increased risk of concentration-dependent adverse effects.	Based on the CYP2C9 genotype, CPIC guidelines[21] provide a moderate recommendation to use the typical initial or loading dose and for subsequent doses to use approximately 25% less than the typical maintenance dose. Subsequent dose adjustments should be guided by therapeutic drug monitoring and clinical response. CPIC guidelines also address genetic testing for the presence of the HLA-B*15:02 allele (not currently tested by myDNA, but which may be requested through a local service if required) which is known to increase the risk of phenytoin-induced Stevens-Johnson syndrome and toxic epidermal necrolysis. The guidelines state that if both HLA-B*15:02 and CYP2C9 genotypes are known, consider the HLA-B*15:02 genotype first, then CYP2C9 genotype. In the instance of an HLA-B*15:02 positive result, CPIC guidelines provide a strong recommendation to not use phenytoin/fosphenytoin in patients who have never had phenytoin before, and to also avoid carbamazepine and oxcarbazepine. Phenytoin may be used cautiously in patients who have tolerated the drug previously for longer than three months without occurrence of adverse skin reactions.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
PHENYTOIN Antiepileptics	**CYP2C9 - Intermediate metaboliser:** Reduced phenytoin metabolism and increased drug exposure are predicted. This genotype has been associated with an increased risk of concentration-dependent adverse effects.	Based on the CYP2C9 genotype, CPIC guidelines[21] provide a moderate recommendation to use the typical initial or loading dose and for subsequent doses to use approximately 25% less than the typical maintenance dose. Subsequent dose adjustments should be guided by therapeutic drug monitoring and clinical response. CPIC also addresses genetic testing for the presence of the HLA-B*15:02 allele (not currently tested by myDNA, but which may be requested through a local service if required) which is known to increase the risk of phenytoin-induced Stevens-Johnson syndrome and toxic epidermal necrolysis. The guidelines state that if both HLA-B*15:02 and CYP2C9 genotypes are known, consider the HLA-B*15:02 genotype first, then CYP2C9 genotype. In the instance of an HLA-B*15:02 positive result, CPIC provide a strong recommendation to not use phenytoin in patients who have never had phenytoin before, and to also avoid carbamazepine and oxcarbazepine. Phenytoin may be used cautiously in patients who have tolerated the drug previously for longer than three months without occurrence of adverse skin reactions.
ARIPIPRAZOLE Antipsychotics	**CYP2D6 - Poor metaboliser:** Poor metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	FDA-approved labelling [22] advises use of 50% of the usual dose. Additionally, if aripiprazole is prescribed together with a strong CYP3A4 inhibiting drug, the dose should be reduced to 25% of the usual dose. For the injectable depot (Abilify Maintena®), the FDA-approved label and TGA-approved product information [23] recommends for CYP2D6 poor metabolisers to use a starting and maintenance dose of 300 mg and for CYP2D6 poor metabolisers taking CYP3A4 inhibitors, a 200 mg dose is advised. Note the DPWG[24] recommends administering no more than 10mg/day (~300 mg/month (68-75% of the standard maximum dose), for CYP2D6 poor metabolisers.
BREXPIPRAZOLE Antipsychotics	**CYP2D6 - Poor metaboliser:** Poor metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	DPWG guidelines and FDA-approved labelling[25], [26] advise initial treatment with 50% of the usual dose and adjusting according to clinical response. Additionally, if brexpiprazole is prescribed together with a strong CYP3A4 inhibiting drug, the dose should be reduced to 25% of the usual dose.[26]
HALOPERIDOL Antipsychotics	**CYP2D6 - Poor metaboliser:** Poor reduced metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	The DPWG[27] suggests reducing the initial dose of haloperidol by 50% and adjusting to effect, or using an alternative drug.
RISPERIDONE Antipsychotics	**CYP2D6 - Poor metaboliser:** Poor metabolism and increased drug exposure to risperidone is predicted. This has been associated with both an increased risk of certain adverse effects and a stronger decrease in symptoms when used in schizophrenia. An increased proportion of therapeutic failure has been observed with this genotype.	The DPWG[28] suggests using 67% of the standard dose. If problematic side effects originating from the central nervous system occur despite this reduced dose, a further reduction in dose to 50% of the standard dose is advised.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
ZUCLOPENTHIXOL Antipsychotics ⚠	**CYP2D6 - Poor metaboliser:** Poor metabolism and increased drug exposure are predicted. This has been associated with an increased risk of adverse effects.	The DPWG[29] advises starting with 50% of the standard dose or selecting an alternative drug according to current guidelines.
DEXTROMETHORPHAN Antitussives	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism and increased drug exposure are predicted. This may increase the risk of adverse effects.	No genotype-guided dosing recommendation available. Monitor for adverse effects.
METOPROLOL Beta blockers	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and greatly increased metoprolol exposure are predicted. Clinical consequences are limited mainly to the occurrence of asymptomatic bradycardia.	Be alert to adverse effects such as bradycardia. Where a more gradual reduction in heart rate is desired, or where there are greater concerns for symptomatic bradycardia, DPWG[30] has recommendations to increase the dose in smaller steps and/or prescribe no more than 25% of the standard dose. If currently well tolerated and clinical response has been adequate, a change to therapy may not be required.
TIMOLOL Beta blockers	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and increased drug exposure are predicted. The poor metaboliser phenotype has been associated with increased clinical effects, including systemic beta-blocking adverse effects, observed with ophthalmic timolol aqueous (but not gel) preparations.	Monitor for systemic beta blocker adverse effects such as bradycardia and bronchospasm.
TACROLIMUS Calcineurin inhibitors	**CYP3A5 - Intermediate metaboliser:** Intermediate metabolism of tacrolimus is predicted. Lower dose-adjusted plasma concentrations of tacrolimus are also predicted when usual prescribing procedures are followed (note that the majority of Caucasians are poor metabolisers of tacrolimus who tend to have higher drug concentrations and prescribing procedures were developed for them). This is associated with a reduction in time that the tacrolimus concentration is in the therapeutic range and potentially with increased risk for transplant rejection.	For use in transplant recipients, other than in liver transplant where donor and recipient livers are of different genotypes, most guidelines[31] recommend using an increased starting dose 1.5-2 times the recommended starting dose. Starting oral dose should not exceed 0.3mg/kg/day. Therapeutic drug monitoring should guide ongoing dose adjustments. DPWG guideline[2] recommendations are to use 1.5 times the initial dose and adjust based on therapeutic drug monitoring. In liver transplants where the transplanted liver has a different genotype from the recipient's genotype, there is insufficient evidence to support a dose recommendation.[31, 32]
DAPOXETINE Drugs for sexual dysfunction ⚠	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of adverse effects. Concomitant use with CYP3A4 inhibiting drugs may be expected to further increase dapoxetine exposure and the risk of adverse effects.	The TGA[33] approved product information recommends caution with prescribing, given the increased predicted drug exposure. Consider alternative therapy. If using dapoxetine, monitor closely for adverse effects.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
TAMOXIFEN Immunomodulators and antineoplastics ⚠	**CYP2D6 - Poor metaboliser:** Reduced formation of tamoxifen's active metabolite endoxifen by CYP2D6 is predicted. There is conflicting evidence on the effect of this genotype on cancer outcomes. Some studies have shown an increased risk of disease recurrence and higher mortality, whilst others have not shown such effects.	For the adjuvant treatment of ER+ breast cancer, CPIC guidelines[34] provides a strong recommendation to use alternative hormonal therapy such as an aromatase inhibitor for postmenopausal women or aromatase inhibitor along with ovarian function suppression in premenopausal women. Note that higher dose tamoxifen (40mg/d) increases but does not normalize endoxifen concentrations, and can be considered if there are contraindications to aromatase inhibitor therapy.
ELIGLUSTAT Miscellaneous	**CYP2D6 - Poor metaboliser:** Negligible metabolism of eliglustat by CYP2D6 and greatly increased drug exposure are predicted. Increased risk of adverse effects such as small dose dependent elongation of the QT interval, especially if appropriate dose adjustments are not made. CYP3A4 inhibitors increase this risk further.[35]	The recommended dose of eliglustat depends on whether CYP3A4 and/or CYP2D6 inhibiting medications are co-prescribed. Refer to DPWG guidelines,[35] FDA-approved drug label[36] or TGA-approved product information[37] for prescribing details.
TAMSULOSIN Miscellaneous	**CYP2D6 - Poor metaboliser:** Reduced metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects. Concomitant use with CYP3A4 inhibiting drugs may be expected to further increase tamsulosin exposure and the risk of adverse effects.	Monitor for adverse effects. The FDA[38] has cautioned regarding this genotype and recommends the 0.4mg dose should not be used with strong inhibitors of CYP3A4 and should be used with caution in combination with strong or moderate inhibitors of CYP2D6 or in patients known to be CYP2D6 poor metabolisers, particularly at a dose higher than 0.4mg.
SIPONIMOD Neurological drugs	**CYP2C9 - Intermediate metaboliser:** A reduced metabolism of siponimod and higher plasma concentration is predicted with the *1/*3 genotype, and by extension, other genotypes with comparable genetic variations to *1/*3.	DPWG[39] and the FDA-approved drug label[40] recommend the use of 50% of the normal maintenance dose in patients with the CYP2C9 *1/*3 genotype. The FDA-approved drug label states that in patients with the CYP2C9 *1/*3 genotype, treatment initiation should be with a 4-day titration, starting at 0.25 mg daily and gradually increasing until the maintenance dose of 1 mg on Day 5 of treatment. They also advise reconsideration or recommend against concomitant use of siponimod with moderate or strong CYP3A4 inducers in such patients due to a decrease in siponimod exposure. It would be reasonable to apply this recommendation to patients with a comparable genetic variation.
TETRABENAZINE Neurological drugs	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	The FDA[41] approved drug label advises a maximum daily dose of 50mg, with a maximum recommended single dose of 25mg.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
CELECOXIB NSAIDs	**CYP2C9 - Intermediate metaboliser:** Moderately reduced metabolism and increased celecoxib exposure are predicted[42]. This may increase the risk of concentration-dependent adverse effects such as gastrointestinal bleeding[43].	CPIC guidelines[5] have a moderate recommendation to initiate therapy with the lowest recommended starting dose. Titrate upward to clinical effect or maximum recommended dose with caution. In accordance with prescribing information, use the lowest effective dose for the shortest duration required. Carefully monitor for adverse effects such as blood pressure and kidney function. Consider general measures to manage the risk of toxicity such as considering alternative treatments, using the lowest effective dose and gastroprotective agents as clinically appropriate.
IBUPROFEN NSAIDs	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism by CYP2C9 and increased drug exposure are predicted[4]. This has been associated with an increased risk of adverse effects, including gastrointestinal bleeding[4].	CPIC guidelines[5] have a moderate recommendation to initiate therapy with the lowest recommended starting dose. Titrate upward to clinical effect or maximum recommended dose with caution. In accordance with prescribing information, use the lowest effective dose for the shortest duration required. Carefully monitor for adverse effects such as blood pressure and kidney function. Consider general measures to manage the risk of toxicity such as considering alternative treatments, using the lowest effective dose and gastroprotective agents as clinically appropriate.
MELOXICAM NSAIDs	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism by CYP2C9 and increased drug exposure are predicted.[4] This may be associated with an increased risk of adverse effects, including gastrointestinal bleeding.[43]	CPIC guidelines[5] have a moderate recommendation to initiate therapy with 50% of the lowest recommended starting dose. Titrate upward to the clinical effect or 50% of the maximum recommended dose with caution. In accordance with prescribing information, use the lowest effective dose for the shortest duration required. Upward dose titration should not occur until after steady state is reached (at least 7 days). Carefully monitor adverse events such as blood pressure and kidney function. Alternatively, consider an alternative therapy not metabolised by CYP2C9 or not significantly impacted by CYP2C9 genetic variants in vivo (such as aspirin, ketorolac, naproxen or sulindac), or choose an NSAID metabolised by CYP2C9 but with a shorter half life (such as celecoxib, flurbiprofen, ibuprofen or lornoxicam). Consider general measures to manage the risk of toxicity such as considering alternative treatments, using the lowest effective dose and gastroprotective agents as clinically appropriate.
PIROXICAM NSAIDs ⚠	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism by CYP2C9 and increased drug exposure are predicted.[4] This has been associated with an increased risk of adverse effects, including gastrointestinal bleeding[43].	CPIC guidelines[5] have a moderate recommendation to choose an alternative therapy not metabolised by CYP2C9 or not significantly impacted by CYP2C9 variants in vivo (such as aspirin, ketorolac, naproxen or sulindac), or choose an NSAID metabolised by CYP2C9 but with a shorter half-life (such as celecoxib, flurbiprofen, ibuprofen or lornoxicam).

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
CODEINE Opioid Analgesics	**CYP2D6 - Poor metaboliser** **OPRM1 - Lower opioid sensitivity:** Greatly reduced metabolism of codeine into its active metabolite morphine. There is a high likelihood of an inadequate analgesic response to codeine.[2] Whilst this OPRM1 genotype has been associated with reduced sensitivity to morphine and by extrapolation, to codeine as well, there is insufficient evidence for its clinical significance.	Based on the CYP2D6 genotype CPIC[3] provides a strong recommendation to avoid codeine use because of possibility of diminished analgesia. If opioid use is warranted, consider a non-tramadol opioid. There is no additional genotype-guided dosing recommendation based on the OPRM1 result.
TRAMADOL Opioid Analgesics	**CYP2D6 - Poor metaboliser:** Negligible formation of tramadol's active metabolite is predicted. This could lead to a reduction in analgesic response. Note that tramadol is a serotonergic drug. There is an increased risk of serotonin toxicity when used together with other serotonergic drugs.	CPIC guidelines[3] provide a strong recommendation to avoid tramadol use because of possibility of diminished analgesia. If opioid use is warranted, consider a non-codeine opioid.
ATORVASTATIN Statins	**SLCO1B1 - Decreased transport function:** This SLCO1B1 genotype is associated with increased atorvastatin exposure compared with a normal function genotype, which may translate to increased risk of atorvastatin related myopathy.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	Based on this SLCO1B1 genotype, CPIC guidelines[1] provide a moderate recommendation to prescribe less than or equal to 40 mg as a starting dose and adjust doses based on disease-specific guidelines. Be aware of possible increased risk for myopathy especially for the 40 mg dose. If doses >40mg are needed for desired efficacy, consider combination therapy (i.e. atorvastatin plus non-statin guideline directed medical therapy). Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Atorvastatin 80mg - High SAMS risk If used < 1 year: Consider changing to a statin/dose combination with lower SAMS risk. If used > 1 year without SAMS: it is reasonable to continue. Atorvastatin 40mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue. Atorvastatin 10-20mg - Low SAMS risk.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
FLUVASTATIN Statins	**SLCO1B1 - Decreased transporter function** **CYP2C9 - Intermediate metaboliser:** This SLCO1B1 genotype is associated with an increased exposure to fluvastatin as compared with the normal function genotype; there is typical myopathy risk with doses of less than or equal to 40mg.[1] This CYP2C9 genotype predicts increased fluvastatin exposure as compared with normal metabolisers, which may translate to increased myopathy risk.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	CPIC guidelines[1] provide an optional recommendation to prescribe less than or equal to 20mg daily as a starting dose and adjust doses based on disease-specific guidelines. If doses >20mg are required for desired efficacy, consider an alternative statin or combination therapy (i.e. fluvastatin plus non-statin guideline directed medical therapy).
LOVASTATIN Statins ⚠	**SLCO1B1 - Decreased transporter function:** This SLCO1B1 genotype is associated with an increased lovastatin exposure compared with a normal function genotype, which may translate to increased myopathy risk.[1] Other factors that may further increase this myopathy risk: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	CPIC guidelines[1] provide a moderate recommendation to prescribe an alternative statin depending on the desired potency. If lovastatin therapy is warranted, limit dose to less than or equal to 20mg daily. Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Lovastatin 40-80mg - High SAMS risk If used < 1 year: Consider changing to a statin/dose combination with lower SAMS risk. If used > 1 year without SAMS: it is reasonable to continue. Lovastatin 20mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue.

MAJOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
PITAVASTATIN Statins	**SLCO1B1 - Decreased transporter function:** This SLCO1B1 genotype is associated with an increased pitavastatin exposure compared with a normal function genotype, which may translate to increased myopathy risk.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	CPIC guidelines[1] provide a moderate recommendation to prescribe a less than or equal to 2 mg starting dose and adjust doses based on disease-specific guidelines. Be aware of possible increased risk for myopathy, especially for doses >1 mg. If a dose >2 mg is required for desired efficacy, consider an alternative statin or combination therapy (i.e. pitavastatin plus non-statin guideline directed medical therapy). Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Pitavastatin 4mg - High SAMS risk If used < 1 year: Consider changing to a statin/dose combination with lower SAMS risk. If used > 1 year without SAMS: it is reasonable to continue. Pitavastatin 2mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue. Pitavastatin 1mg - Low SAMS risk.
SIMVASTATIN Statins ⚠	**SLCO1B1 - Decreased transporter function:** This SLCO1B1 genotype is associated with increased simvastatin exposure and increased myopathy risk compared with the normal function genotype.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	Based on this SLCO1B1 genotype, CPIC guidelines[1] provide a strong recommendation to prescribe an alternative statin depending on desired potency. If simvastatin therapy is warranted, limit dose to <20 mg daily. Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Simvastatin 20-40mg - High SAMS risk If used < 1 year: Consider changing to a statin/dose combination with lower SAMS risk. If used > 1 year without SAMS: it is reasonable to continue. Simvastatin 10mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue.

MINOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
IRBESARTAN Angiotensin receptor blockers	**CYP2C9 - Intermediate metaboliser:** Reduced irbesartan metabolism and increased drug exposure are predicted. This may be associated with a greater blood pressure lowering effect as well as concentration-dependent adverse effect.	No genotype-guided dosing recommendation available. Monitor for adverse effects.
LOSARTAN Angiotensin receptor blockers	**CYP2C9 - Intermediate metaboliser:** A reduction in the formation of losartan's active metabolite is predicted. This may be exacerbated by the co-administration of CYP2C9 inhibiting medications. This may lead to reduced clinical effects.	No genotype-guided dosing recommendation available. Monitor for a reduced clinical response and consider alternative therapy as required.
DARIFENACIN Anticholinergics (genitourinary)	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of adverse effects.[45] Concomitant use with CYP3A4 inhibiting drugs may be expected to further increase darifenacin exposure and the risk of adverse effects.	No genotype-guided dosing recommendation available. Caution with co-administered CYP3A4 inhibiting drugs. Monitor for adverse effects.
DONEPEZIL Anticholinesterases	**CYP2D6 - Poor metaboliser:** Negligible metabolism via CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects and a poorer response to therapy.	No genotype-guided dosing recommendation available. Monitor for adverse effects or a poor response to therapy. Note that the CYP2D6 genotype is not expected to affect the metabolism of an alternate cholinesterase inhibitor, rivastigmine.
GALANTAMINE Anticholinesterases	**CYP2D6 - Poor metaboliser:** Negligible metabolism via CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	The FDA-approved drug label[47] states that dosage adjustment of galantamine is not necessary in patients identified as CYP2D6 poor metabolisers as the dose is individually titrated to tolerability. Monitor for adverse effects or a poor response to therapy. Note that the CYP2D6 genotype is not expected to affect the metabolism of an alternate cholinesterase inhibitor, rivastigmine.
AGOMELATINE Antidepressants - other	**CYP1A2 - Ultrarapid metaboliser (with inducer present):** Increased agomelatine metabolism and reduced plasma concentrations are predicted[48, 49]. This effect is expected to be enhanced with exposure to enzyme inducers such as tobacco smoking, daily consumption of cruciferous vegetables or chargrilled meat, and certain medications (e.g. omeprazole). The clinical significance of this has not yet been established.	No genotype-guided dosing recommendation available. It would be reasonable to monitor for an adequate clinical response.
MIANSERIN Antidepressants - other	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and increased drug exposure are predicted. This could increase the risk of adverse effects.	No genotype guided dosing recommendation is available. Be alert for adverse effects.

MINOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
MIRTAZAPINE Antidepressants - other	**CYP2D6 - Poor metaboliser** **CYP1A2 - Ultrarapid metaboliser (with inducer present):** Mirtazapine is metabolised by a number of enzymes, including CYP2D6 and CYP1A2. Negligible metabolism by CYP2D6 and increased metabolism by CYP1A2 in the presence of enzyme inducers (e.g. cigarette smoking) are predicted. The overall effect on plasma concentrations and clinical effects is difficult to predict.	Monitor for altered clinical effect. Based on the CYP2D6 genotype, DPWG suggests that no specific action on mirtazapine dosing is required.[50]
DULOXETINE Antidepressants - SNRIs	**CYP2D6 - Poor metaboliser** **CYP1A2 - Ultrarapid metaboliser (with inducer present):** Duloxetine is metabolised by both CYP1A2 and CYP2D6, with CYP1A2 likely to have the major role. Negligible duloxetine metabolism by CYP2D6 and increased metabolism by CYP1A2 in patients exposed to enzyme inducers (e.g. cigarette smoking) are predicted. The overall effect on duloxetine plasma concentrations and clinical response is difficult to predict. The FDA-approved drug label[51] notes that concomitant administration of duloxetine and a potent CYP1A2 inhibitor to CYP2D6 poor metabolisers resulted in significant increase in drug exposure.	No genotype-guided dosing recommendation available. Be alert to an inadequate response, especially in smokers.
GLIBENCLAMIDE Antidiabetics	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism and increased drug exposure are predicted. This has been associated with a greater reduction in HbA1c as well as increased likelihood of hypoglycaemia.	DPWG suggests that no specific action on glibenclamide dosing is required with this genotype.[52] It would be reasonable to consider a lower starting dose with close monitoring for adverse effects.
GLICLAZIDE Antidiabetics	**CYP2C9 - Intermediate metaboliser** **CYP2C19 - Normal metaboliser:** This CYP2C9 genotype has been associated with increased clinical effects (hypoglycaemia, reduced HbA1c). This CYP2C19 genotype predicts normal metabolism of gliclazide. The overall effect of both genotypes is not known for sure.	Based on the CYP2C9 genotype, DPWG suggests that no specific action on gliclazide dosing is required with this genotype.[53]
GLIMEPIRIDE Antidiabetics	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism and increased drug exposure are predicted. This has been associated with a greater reduction in HbA1c as well as increased likelihood of hypoglycaemia.	DPWG suggests that no specific action on glimepiride dosing is required with this genotype.[54] It would be reasonable to consider a lower starting dose with close monitoring for adverse effects.
GLIPIZIDE Antidiabetics	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism and increased drug exposure are predicted. This may be associated with an increase in insulin response to glipizide and has also been linked to an increased likelihood of hypoglycaemia, in patients over 60 years of age.[55]	No genotype guided dosing recommendation available. It may be reasonable to consider a lower starting dose with close monitoring for adverse effects.

MINOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
CHLORPHENIRAMINE Antihistamines	**CYP2D6 - Poor metaboliser:** Reduced metabolism of chlorpheniramine and increased drug exposure are predicted. There may potentially be an increased risk of adverse effects, such as drowsiness, although evidence for this is limited.	No genotype-guided dosing recommendation available. Consider using a lower starting dose. Monitor for adverse effects.
DEXCHLORPHENIRAMINE Antihistamines	**CYP2D6 - Poor metaboliser:** Reduced metabolism of dexchlorpheniramine and increased drug exposure are predicted. There may potentially be an increased risk of adverse effects, such as drowsiness, although evidence for this is limited.	No genotype-guided dosing recommendation available. Consider using a lower starting dose. Monitor for adverse effects.
PROMETHAZINE Antihistamines	**CYP2D6 - Poor metaboliser:** Reduced metabolism of promethazine and increased drug exposure are predicted. There may potentially be an increased risk of adverse effects, such as drowsiness, although evidence for this is limited.	No genotype-guided dosing recommendation available. Consider using a lower starting dose. Monitor for adverse effects.
CHLORPROMAZINE Antipsychotics	**CYP2D6 - Poor metaboliser:** Greatly reduced metabolism of chlorpromazine by CYP2D6 and increased drug exposure are predicted. There may be an increased risk of adverse effects.	No genotype-guided dosing recommendation available. Monitor for adverse effects.
CLOZAPINE Antipsychotics	**CYP2D6 - Poor metaboliser** **CYP1A2 - Ultrarapid metaboliser (with inducer present):** Based on the CYP1A2 genotype, increased metabolism of clozapine and reduced drug exposure are predicted, especially in the presence of inducers such as tobacco smoking, daily consumption of cruciferous vegetables or chargrilled meat, and certain medications (e.g. omeprazole). This CYP1A2 genotype has also been associated with a reduced clinical response to clozapine, which is more marked in smokers.[56] The FDA-approved drug label[57] states that in CYP2D6 poor metabolisers, plasma concentrations of clozapine may be increased.	Based on the CYP1A2 genotype, no genotype-guided dosing recommendation available. Monitor for reduced clinical effect, especially in a patient exposed to enzyme inducers. If exposure to enzyme inducers stops abruptly (e.g. tobacco smoking cessation) monitor for emergent concentration-dependent adverse effects. Some authorities have recommended a dose reduction at the time of smoking cessation.[58] Based on the CYP2D6 genotype, the FDA-approved drug label[57] states that it may be necessary to reduce the dose in CYP2D6 poor metabolisers, as they may develop higher than expected plasma concentrations when given usual doses.
OLANZAPINE Antipsychotics	**CYP1A2 - Ultrarapid metaboliser (with inducer present):** Increased metabolism of olanzapine and reduced drug exposure are predicted, especially in the presence of inducers such as tobacco smoking, daily consumption of cruciferous vegetables or chargrilled meat, and certain medications (e.g. omeprazole).This genotype has been associated with a reduced clinical response to olanzapine independent of smoking, but this has not been confirmed in all studies.	No genotype-guided dosing recommendation available. Monitor for reduced clinical effect, especially in a patient exposed to enzyme inducers. If exposure to enzyme inducers stops abruptly (e.g. tobacco smoking cessation) monitor for emergent concentration-dependent adverse effects. Some authorities have recommended a dose reduction at the time of smoking cessation.[58]

MINOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
QUETIAPINE Antipsychotics	**CYP3A4 - Intermediate metaboliser:** Reduced metabolism of quetiapine to inactive metabolites and an active metabolite with anti-depressant effects. Effect on plasma concentration is limited (20% increase compared with normal metabolisers)[59],[60] This may potentially be associated with increased clinical effects (therapeutic and/or adverse), although direct evidence is lacking.	The DPWG guidelines state that no action is required based on this genotype.[59] Be alert for increased clinical effects.
CARVEDILOL Beta blockers	**CYP2D6 - Poor metaboliser:** Negligible metabolism by CYP2D6 and increased drug exposure are predicted. This could potentially lead to increased clinical effects, although the evidence for this with carvedilol is weak. The FDA-approved drug label notes that poor metabolisers had a higher rate of dizziness during up-titration.[61]	DPWG[62] suggests that no specific action on carvedilol dosing is required based on this genotype. Monitor for adverse effects.
PROPRANOLOL Beta blockers	**CYP2D6 - Poor metaboliser** **CYP1A2 - Ultrarapid metaboliser (with inducer present)** Propranolol is metabolised by both CYP2D6 and CYP1A2 and also has an active metabolite. This genotype predicts negligible metabolism by CYP2D6 and increased metabolism by CYP1A2 (the latter mainly in the presence of inducers such as cigarette smoke). The overall effect on drug exposure is not known. The FDA[63] notes that systemic concentrations may be affected in CYP2D6 poor metabolisers.	No genotype-guided dosing guideline available. Monitor for altered clinical effect.
GEFITINIB Immunomodulators and antineoplastics	**CYP2D6 - Poor metaboliser:** Poor metabolism by CYP2D6 and increased drug exposure are predicted. This may increase the risk of concentration-dependent adverse effects.	The FDA-approved drug label[64] advises that there is no dose adjustment recommendations for gefitinib in individuals with a known CYP2D6 poor metaboliser genotype, but they should be closely monitored for adverse reaction. The DPWG[65] suggests that no specific action on gefitinib dosing is required with this genetic result.
ATAZANAVIR Miscellaneous	**CYP3A5 - Intermediate metaboliser:** Moderately increased atazanavir metabolism and reduced drug exposure are predicted (metabolism is increased when compared with most Caucasian people who are CYP3A5 poor metabolisers). Co-administration with ritonavir ("ritonavir-boosting") may partly or wholly offset the increased atazanavir metabolism associated with this genotype[66]. Note that a test for a variation in the UGT1A1 gene is available. This test is useful for predicting the risk of atazanavir-induced hyperbilirubinemia.	No genotype-guided dosing recommendation available. Monitor for a reduced clinical effect.

MINOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
MEFENAMIC ACID NSAIDs	**CYP2C9 - Intermediate metaboliser:** Mefenamic acid is metabolised by CYP2C9.[67] This genotype predicts an increase in mefenamic acid exposure which may potentially increase the risk of adverse effects[68], especially with high dosages or if drug-drug interactions occur.	Standard dosing and prescribing measures apply. Monitor for adverse effects.
OXYCODONE Opioid Analgesics	**CYP2D6 - Poor metaboliser:** Significantly reduced exposure to oxycodone's active metabolite, oxymorphone, is predicted. Although this may potentially lead to reduced analgesia or increased oxycodone consumption, there is limited evidence to suggest that this is clinically significant.	DPWG[69] suggest that no specific action on oxycodone dosing is required. Be alert to a reduced response.
LANSOPRAZOLE Proton pump inhibitors	**CYP2C19 - Normal metaboliser:** This genotype predicts typical metabolism of lansoprazole. However, this rate of metabolism has been associated with a potentially incomplete clinical response in conditions such as oesophagitis and H. pylori, compared to intermediate and poor metabolisers.	CPIC guidelines have a moderate recommendation to initiate a standard starting daily dose. Consider increasing the dose by 50-100% for the treatment of H. pylori infection and erosive esophagitis, and giving the daily dose in divided doses.[70] If response is inadequate, consider the use of esomeprazole or rabeprazole.
OMEPRAZOLE Proton pump inhibitors	**CYP2C19 - Normal metaboliser:** This genotype predicts typical metabolism of omeprazole. However, this rate of metabolism has been associated with a potentially incomplete clinical response in conditions such as oesophagitis and H. pylori, compared to intermediate and poor metabolisers.	CPIC guidelines have a moderate recommendation to initiate a standard starting daily dose. Consider increasing the dose by 50-100% for the treatment of H. pylori infection and erosive esophagitis, and giving the daily dose in divided doses.[70] If response is inadequate, consider use of esomeprazole or rabeprazole.
PANTOPRAZOLE Proton pump inhibitors	**CYP2C19 - Normal metaboliser:** This genotype predicts typical metabolism of pantoprazole. However, this rate of metabolism has been associated with a potentially incomplete clinical response in conditions such as oesophagitis and H. pylori, compared to intermediate and poor metabolisers.	CPIC guidelines have a moderate recommendation to initiate a standard starting daily dose. Consider increasing the dose by 50-100% for the treatment of H. pylori infection and erosive esophagitis, and giving the daily dose in divided doses.[70] If response is inadequate, consider the use of esomeprazole or rabeprazole.
DEXAMPHETAMINE Psychostimulants	**CYP2D6 - Poor metaboliser:** Dexamphetamine is eliminated by both the kidney (as unchanged drug) and the liver, with CYP2D6 playing a significant role. Negligible metabolism via CYP2D6 and increased dexamphetamine exposure is predicted. Clinical effects may be increased.	The FDA-approved drug label suggests a lower starting dose and monitoring for adverse effects where there is a lack of CYP2D6 function.[71] .

MINOR PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
LISDEXAMFETAMINE Psychostimulants	**CYP2D6 - Poor metaboliser:** Lisdexamfetamine is a prodrug of dextroamphetamine (also known as dexamfetamine). Dextroamphetamine is eliminated by both the kidney (as unchanged drug) and the liver, with CYP2D6 playing a significant role. Negligible metabolism via CYP2D6 and increased dextroamphetamine exposure is predicted. Clinical effects may be increased.	The FDA-approved drug label suggests a lower starting dose and monitoring for adverse effects where there is a lack of CYP2D6 function.[72]
PRAVASTATIN Statins	**SLCO1B1 - Decreased transporter function:** This SLCO1B1 genotype is associated with an increased pravastatin exposure compared with a normal function genotype. There is a typical myopathy risk with doses less than or equal to 40mg.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	CPIC guidelines[1] provide a moderate recommendation to prescribe the desired starting dose and adjust doses based on disease specific guidelines. Be aware of possible increased risk for myopathy, especially with doses >40mg daily. Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Pravastatin 80mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue. Pravastatin 10-40mg - Low SAMS risk.
ROSUVASTATIN Statins	**SLCO1B1 - Decreased transporter function:** This SLCO1B1 genotype is associated with an increased rosuvastatin exposure compared with a normal function genotype, however is associated with a typical myopathy risk with doses of rosuvastatin up to 20mg.[1] Other factors that may further increase this myopathy risk include: higher doses, certain co-administered drugs, female sex, patient frailty, renal failure, hypothyroidism, advanced age, low BMI, intense physical exercise and Asian or African ancestry.	CPIC guidelines[1] provide a strong recommendation to prescribe the desired starting dose and adjust doses according to disease-specific and specific population guidelines. Be aware of possible increased risk for myopathy, especially for doses over 20 mg. Based on this SLCO1B1 genotype, the risk of statin-associated musculoskeletal symptoms (SAMS)[1] is as follows: Rosuvastatin 40mg - Moderate SAMS risk If used < 4 weeks: Consider changing to a statin/dose combination with lower SAMS risk. If used > 4 weeks without SAMS: it is reasonable to continue. Rosuvastatin 5-20mg - Low SAMS risk.

USUAL PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
PRASUGREL Anticoagulants	**CYP2C19 - Normal metaboliser:** DPWG[73] states that there is no gene-drug interaction for CYP2C19 and prasugrel.	No genotype-guided dosing recommendation available for this genotype. Standard dosing and prescribing measures apply.
TICAGRELOR Anticoagulants	**CYP2C19 - Normal metaboliser:** DPWG[74] states that there is no gene-drug interaction for ticagrelor and CYP2C19.	No genotype-guided dosing recommendation available for this genotype. Standard dosing and prescribing measures apply.
MOCLOBEMIDE Antidepressants - other	**CYP2C19 - Normal metaboliser:** Normal metabolism of moclobemide is predicted.	Standard dosing and prescribing measures apply.
CITALOPRAM Antidepressants - SSRIs	**CYP2C19 - Normal metaboliser:** Normal metabolism of citalopram by CYP2C19 is predicted.	CPIC guidelines[16] provide a strong recommendation to initiate therapy with the recommended starting dose.
ESCITALOPRAM Antidepressants - SSRIs	**CYP2C19 - Normal metaboliser:** Normal metabolism of escitalopram by CYP2C19 is predicted.	CPIC guidelines[16] provide a strong recommendation to initiate therapy with the recommended starting dose.
SERTRALINE Antidepressants - SSRIs	**CYP2C19 - Normal metaboliser:** Normal metabolism of sertraline by CYP2C19 is predicted.	CPIC guidelines[16] provide a strong recommendation to initiate therapy with the recommended starting dose
TOLBUTAMIDE Antidiabetics	**CYP2C9 - Intermediate metaboliser:** Reduced metabolism of tolbutamide by CYP2C9 is predicted. This has been associated with a reduction in glucose concentration in some studies[75].	DPWG[76] states that there is no action needed for this gene-drug interaction.
VORICONAZOLE Antifungals - Azoles	**CYP2C19 - Normal metaboliser:** Normal voriconazole metabolism is predicted.	CPIC guidelines[77] provide a strong recommendation to initiate therapy with the recommended standard of care dosing.
CLOPIDOGREL Antiplatelet drugs	**CYP2C19 - Normal metaboliser:** Normal formation of clopidogrel's active metabolite is predicted.	CPIC guidelines[78] provide a strong recommendation to use the label-recommended dosage if clopidogrel is being prescribed for cardiovascular or neurovascular indications.
FLUPENTHIXOL Antipsychotics	**CYP2D6 - Poor metaboliser:** DPWG guidelines[79] state that there is no gene-drug interaction for flupenthixol and CYP2D6.	No dosage recommendations currently available based on the genetic findings.
CLOBAZAM Benzodiazepines	**CYP2C19 - Normal metaboliser:** Clobazam is metabolised by CYP3A4 into an active metabolite, N-desmethylclobazam, which is responsible for most of the therapeutic effect. N-desmethylclobazam is further metabolised by CYP2C19 into an inactive metabolite. Normal metabolism of clobazam's active metabolite is predicted. (Note that the effect of variations in CYP3A4 has not been described).	Standard dosing and prescribing measures apply.

USUAL PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
DIAZEPAM Benzodiazepines	**CYP2C19 - Normal metaboliser:** Diazepam is metabolised by CYP3A4 and CYP2C19 into active metabolites, including desmethyldiazepam, which has a long half-life. The CYP2C19 genotype predicts normal CYP2C19-mediated metabolism of both diazepam and desmethyldiazepam. (Note that the effect of variations in the CYP3A4 gene on diazepam metabolism have not been described).	Standard dosing and prescribing measures apply.
NEBIVOLOL Beta blockers	**CYP2D6 - Poor metaboliser:** Negligible nebivolol metabolism by CYP2D6 and increased drug exposure are predicted. However, this has not been convincingly linked to increased beta blocking effects.	The FDA-approved drug label[80] states that no dose adjustments are necessary for CYP2D6 poor metabolisers, as the clinical effect and safety profile were similar between poor and extensive metabolisers. Be alert for excessive beta blockade.
NALTREXONE Drugs for alcohol dependence	**OPRM1 - Lower opioid sensitivity:** There is currently insufficient evidence to support an association between the OPRM1 genotype and the response to naltrexone. It has been suggested that the G allele may be associated with a lower relapse rate, longer time to relapse and less heavy drinking days when naltrexone is used in the management of alcohol use disorder in a few studies, however in other studies and a recent meta-analysis, this was not observed.[81]	CPIC guidelines[3] state that there is insufficient evidence to provide a recommendation for naltrexone dosing based on OPRM1 genotype. Usual prescribing considerations apply.
MELATONIN Hypnotics	**CYP1A2 - Ultrarapid metaboliser (with inducer present):** Increased metabolism of melatonin and reduced exposure, especially in the presence of inducers such as tobacco smoking, daily consumption of cruciferous vegetables or chargrilled meat and certain medications (e.g. omeprazole).[82] The clinical significance of this is not known.	No genotype-guided dosing recommendation available. It would be reasonable to monitor for an adequate clinical response.
CYCLOPHOSPHAMIDE Miscellaneous	**CYP2C19 - Normal metaboliser:** Normal metabolism of cyclophosphamide by CYP2C19 into its active metabolite is predicted.	No genotype-guided dosing recommendation available.
PROGUANIL Miscellaneous	**CYP2C19 - Normal metaboliser:** Normal metabolism of proguanil into its active metabolite cycloguanil is predicted.	No genotype-guided dosing recommendation available.
DICLOFENAC NSAIDs	**CYP2C9 - Intermediate metaboliser:** Diclofenac is only partially metabolised by CYP2C9. This genotype predicts a reduction in diclofenac metabolism by CYP2C9. Whilst this could lead to a small increase in diclofenac exposure,[83] the clinical significance has not been demonstrated.	CPIC guidelines[5] state that there is insufficient evidence to provide a recommendation to guide clinical practice at this time. Standard dosing and prescribing measures apply. Be alert to adverse effects.

USUAL PRESCRIBING CONSIDERATIONS

MEDICATION DRUG CATEGORY	INTERPRETATION	RECOMMENDATION
INDOMETHACIN NSAIDs	**CYP2C9 - Intermediate metaboliser:** Indomethacin is only partially metabolised by CYP2C9. This genotype predicts a reduction in indomethacin metabolism by CYP2C9. Whilst this could lead to a small increase in indomethacin exposure,[84] the clinical significance has not been demonstrated.	CPIC guidelines[5] state that there is insufficient evidence to provide a recommendation to guide clinical practice at this time. Standard dosing and prescribing measures apply. Be alert to adverse effects.
MORPHINE Opioid Analgesics	**OPRM1 - Lower opioid sensitivity:** Whilst this genotype has been associated with reduced sensitivity to morphine (including slightly increased morphine consumption in post-operative and chronic pain settings), there is insufficient evidence for its clinical significance.	CPIC[3] states that there is insufficient evidence to provide a recommendation to guide clinical practice at this time. Standard dosing and prescribing measures apply. It may be reasonable to consider the possibility of reduced clinical response during dose titration.
ESOMEPRAZOLE Proton pump inhibitors	**CYP2C19 - Normal metaboliser:** Typical metabolism of esomeprazole by CYP2C19 is predicted. Note that this genotype has a lesser effect with esomeprazole and rabeprazole compared to other PPIs.	Standard dosing and prescribing measures apply. If response is inadequate, consider a trial of rabeprazole as an alternative.
RABEPRAZOLE Proton pump inhibitors	**CYP2C19 - Normal metaboliser:** Typical metabolism of rabeprazole by CYP2C19 is predicted. Note that this genotype has a lesser effect with rabeprazole and esomeprazole compared to other PPIs.	Standard dosing and prescribing measures apply. If the response to rabeprazole is inadequate, consider a trial of esomeprazole as an alternative agent.

DETAILED PHARMACOGENOMIC TEST RESULTS

GENE	GENOTYPE	PREDICTED PHENOTYPE
CYP1A2	*1F/*1F	**Ultrarapid metaboliser (with inducer present):** Due to the presence of two *1F alleles, this individual is predicted to have an ultrarapid metaboliser phenotype. Enzyme activity is highest in the presence of inducers, such as tobacco smoke, regular consumption of cruciferous vegetables or chargrilled meats, and certain drugs. For a drug extensively metabolised by CYP1A2, drug exposure and clinical effects may either be reduced (for an active drug) or increased (for a prodrug).
CYP2C19	*1/*1	**Normal metaboliser:** Due to the presence of two normal function alleles, this individual is predicted to have a normal metaboliser phenotype. For a drug extensively metabolised by CYP2C19, drug exposure and clinical effects may be expected to lie within the normal range.
CYP2C9	*1/*3	**Intermediate metaboliser:** Due to the presence of one normal function allele and one null allele, this individual is predicted to have an intermediate metaboliser phenotype. For a drug extensively metabolised by CYP2C9, drug exposure and clinical effects may either be increased (for an active drug) or decreased (for a prodrug). This may increase the likelihood of adverse effects (active drug) or therapeutic failure (prodrug).
CYP2D6	*4/*4	**Poor metaboliser:** Due to the presence of two copies of no function alleles, this individual is predicted to have a poor metaboliser phenotype. For a drug extensively metabolised by CYP2D6, drug exposure and clinical effects may either be greatly increased (for an active drug) or greatly decreased (for a prodrug). The individual is at risk of experiencing adverse effects (active drug) or therapeutic failure (prodrug).
CYP3A4	*1/*22	**Intermediate metaboliser:** This individual carries one copy of the reduced function *22 allele and is predicted to have an intermediate metaboliser phenotype. Reduced metabolism of certain CYP3A4 substrate drugs (e.g. quetiapine) is expected. This may result in increased drug exposure and clinical effects.
CYP3A5	*1/*3	**Intermediate metaboliser:** This individual carries one normal functioning allele and one non-functioning allele and is predicted to have an intermediate metaboliser phenotype (CYP3A5 expresser). CYP3A5 is known to metabolise certain drugs, including tacrolimus.
OPRM1	GG	**Lower opioid sensitivity:** The GG genotype contains two variant alleles for the OPRM1 gene which encodes the mu opioid receptor. Whilst the evidence around OPRM1 genetic variation continues to develop, it appears that the G allele is associated with a reduced response to certain opioids (in particular, morphine). These findings are supported by a number of cohort studies and at least two meta-analyses[85],[86] however, this is not shown in all studies. For naltrexone in the management of alcohol use disorder, some studies have shown an association of the G allele with superior clinical outcomes. Note the frequency of the variant allele (G) is higher in people of Asian ancestry (around 40%) than European ancestry (around 15%).
SLCO1B1	*1/*5	**Decreased transporter function:** This individual carries one copy of the decreased function *5 allele and is predicted to have decreased function of the *SLCO1B1* encoded transporter. Decreased clearance of certain medications such as simvastatin is expected.
VKORC1	GG	**Normal VKORC1 enzyme level:** The VKORC1 enzyme is predicted to be present in normal amounts and the response to warfarin will be normal. The *CYP2C9* genotype should also be considered together with the *VKORC1* genotype for calculating the initial warfarin dose.