HLA-B*5701: abacavir

48% of the HLA-B*5701-positive patients develop a severe and potentially life-threatening hypersensitivity reaction to abacavir.

Abacavir is contra-indicated for HLA-B*5701-positive patients.

- avoid abacavir

Literature:

17. SmPC Ziagen (NL en VS).

Date 13-05-2019

CYP2C9 IM: acenocoumarol

NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

Literature:


27. Visser LE et al. The risk of overanticoagulation in patients with cytochrome P450 CYP2C9*2 or CYP2C9*3 alleles on acenocoumarol or phenprocoumon. Pharmacogenomics 2004;1427-33.


Date 14-05-2018

**CYP2C9 PM: acenocoumarol**

NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

---

**Literature:**

- **CYP2C9 PM: acenocoumarol**
  - 1869

NO action is needed for this gene-drug interaction.

Date 14-05-2018
NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

Literature:

27. Visser LE et al. The risk of overanticoagulation in patients with cytochrome P450 CYP2C9*2 or CYP2C9*3 alleles on acenocoumarol or phenprocoumon. Pharmacogenetics 2004;14:247-33.

Date 14-05-2018

CYP2C9*1/*3: acenocoumarol

NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

Literature:

27. Visser LE et al. The risk of overanticoagulation in patients with cytochrome P450 CYP2C9*2 or CYP2C9*3 alleles on acenocoumarol or phenprocoumon. Pharmacogenetics 2004;14:27-33.

Date 14-05-2018

**CYP2C9*2/*2: acenocoumarol**

NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

**Literature:**

25. Visser LE et al. The risk of overanticoagulation in patients with cytochrome P450 2C9*2 or CYP2C9*3 alleles on acenocoumarol or phenprocoumon. Pharmacogenetics 2004;1427-33.
34. Markatos CN et al. VKORC1 and CYP2C9 allelic variants influence acenocoumarol dose requirements in Greek patients.

Date 14-05-2018

**CYP2C9*2/*3: acenocoumarol**

NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

**Literature:**

NO action is needed for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose and possibly an increase in the time needed to reach a stable INR. However, there is insufficient evidence that this causes problems when therapy is initiated as usual (i.e. with frequent INR monitoring).

Literature:

13. Montes R et al. The influence of polymorphisms of VKORC1 and CYP2C9 on major gastrointestinal bleeding risk in...

Date 14-05-2018

VKORC1 -1639 AA: acenocoumarol

An INR ≥ 6, resulting in an increased risk of bleeding, occurs in 8-12% of these patients during the ﬁrst weeks of treatment with standard regulation by the Anticoagulation Clinic. The genetic variation increases the sensitivity to acenocoumarol.

- Monitoring by the ANTICOAGULATION CLINIC (National INR Monitoring Service):
  - recommend to use 50% of the standard initial dose
- OTHERWISE:
  - recommend to use 50% of the standard initial dose
  - recommend more frequent monitoring of the INR

The initial dose and the maintenance dose can be calculated using an algorithm. However, for patients with two or more VKORC1 and/or CYP2C9 variations, the algorithm used in EU-PACT (see https://www.knmp.nl/patientenzorg/medicatiebewaking/pharmacogenetica for a calculation tool in the form of an Excel ﬁle) did not result in a signiﬁcant reduction in the incidence of INRs above the target range when compared to an algorithm without genetic information. We are therefore unable to recommend the use of this algorithm at this time.

A (non-validated) algorithm has been prescribed for children that should result in a better prediction of the maintenance dose for AA than the current guideline used by the Anticoagulation Clinic (Maagdenberg H et al. The pediatric acenocoumarol dosing algorithm: The Children Anticoagulation and Pharmacogenetics Study. J Thromb Haemost 2018 Jun 23 [Epub ahead of print]. PubMed PMID: 29935043).

Literature:

Date 10-09-2018

VKORC1 -1639 GA: acenocoumarol

NO action is needed for this gene-drug interaction.

The genetic variation results in a reduction of the required dose, but with the current practice of initiating or reviewing treatment this results in little or no increased risk of bleeding or excessive anticoagulation.

Literature:


Date 10-09-2018

**CYP2D6 IM: amiodaron**

This is NOT a gene-drug interaction.

**Literature:**
-

Date 24-08-2016

**CYP2D6 PM: amiodaron**

This is NOT a gene-drug interaction.

**Literature:**
-

Date 24-08-2016

**CYP2D6 UM: amiodaron**

This is NOT a gene-drug interaction.

**Literature:**
-

Date 24-08-2016

**CYP2C19 IM: amitriptyline**

NO action is required for this gene-drug interaction.

The gene variation has an effect on the exposure to amitriptyline, but not on the exposure to amitriptyline + the active metabolite nortriptyline, which determines the effect and side effects.
Literature:


Date 04-03-2019

CYP2C19 PM: amitriptyline

NO action is required for this gene-drug interaction.

The gene variation has an effect on the exposure to amitriptyline, but not on the exposure to amitriptyline + the active metabolite nortriptyline, which determines the effect and side effects.

Literature:

8. SmPC Amitriptyline HCl Apotex.

Date 04-03-2019

CYP2C19 UM: amitriptyline

NO action is required for this gene-drug interaction.

The gene variation decreases the exposure to amitriptyline and increases the exposure to the active metabolite nortriptyline, but there is no evidence to indicate that this results in an increase in side effects or a decrease in efficacy. A higher dose is required to achieve the therapeutic range of amitriptyline+nortriptyline, but the therapeutic range of nortriptyline is achieved at the lower dose.
Literature:


CYP2D6 IM: amitriptyline

The risk of side effects is increased, because the gene variation leads to higher plasma concentrations of the active metabolite nortriptyline and to a lesser extent of amitriptyline.

Recommendation:

- use 75% of the standard dose and monitor the efficacy and side effects or the plasma concentrations of amitriptyline and nortriptyline to adjust the maintenance dose

CYP2D6 PM: amitriptyline

In theory, risk of side effects is increased, because the genetic variation results in higher plasma concentrations of the active metabolite nortriptyline and to a lesser extent of amitriptyline.

- use 70% of the standard dose and monitor the effect and side effects or the plasma concentrations of amitriptyline and nortriptyline to adjust the maintenance dose

Literature:


CYP2D6 UM: amitriptyline

The risk of ineffectiveness is increased and the risk of cardiotoxic side effects may be increased. The gene variation leads to increased conversion of amitriptyline and the active metabolite nortriptyline to less active and inactive metabolites.

- increase the dose to 1.4 times the standard dose, monitor the effect and side effects or the plasma concentrations and be alert to increased plasma concentrations of the cardiotoxic Z-10-hydroxy metabolites.
- Plasma concentrations of Z-hydroxy nortriptyline or Z-hydroxy amitriptyline higher than 40 ng/mL are considered toxic.
- if a dose increase is not desirable due to the cardiotoxic hydroxy metabolite: avoid amitriptyline Anti-depressants that are not metabolised by CYP2D6, or to a lesser extent, include citalopram and sertraline.

Literature:


The heterozygously present genetic polymorphism “factor V Leiden” causes an increased tendency to coagulation, resulting in an increased risk of venous thromboembolism. Contraceptives containing oestrogens can increase this risk even further.

Recommendation:

- If the patient has a FAMILY HISTORY WITH A LOT OF THROMBOSIS, or has had a PREVIOUS THROMBOSIS:
  1. Advise the prescriber to avoid the use of contraceptives that contain oestrogens and prescribe a non-hormone contraceptive - such as a copper IUD - as an alternative. One could also opt for a progestogen-only contraceptive method, such as the depot
injection, an IUD with levonorgestrel or an implant with etonogestrel.

- OTHER CASES:
  1. Advise the patient to avoid additional risk factors for thrombosis (obesity, smoking, etc.).

Literature:


Date 08-06-2005

Fact. V Leiden homozyg: anticoncept. met oestr. 1566

The homozygously present genetic polymorphism “factor V Leiden” causes an increased tendency to coagulation, resulting in an increased risk of venous thromboembolism. Contraceptives containing oestrogens can increase this risk even further.

Recommendation:

- If the patient has a FAMILY HISTORY WITH A LOT OF THROMBOSIS, or has had a PREVIOUS THROMBOSIS:
  1. Advise the prescriber to avoid the use of contraceptives that contain oestrogens and prescribe a non-hormone contraceptive - such as a copper IUD - as an alternative. One could also opt for a progestogen-only contraceptive method, such as the depot injection, an IUD with levonorgestrel or an implant with etonogestrel.

- OTHER CASES:
  1. Advise the patient to avoid additional risk factors for thrombosis (obesity, smoking, etc.).
Literature:


Date 08-06-2005

**CYP2D6 IM: aripiprazol**

NO action is needed for this gene-drug interaction.

The genetic variation increases the plasma concentration of the sum of aripiprazole and the active metabolite dehydroaripiprazole to a limited degree. There is insufficient evidence that this increases the risk of side effects.

Date 14-05-2018

Literature:

CYP2D6 PM: aripiprazol

The risk of side effects is increased. The genetic variation leads to an increase in the sum of the plasma concentrations of aripiprazole and the active metabolite.

- administer no more than 10 mg/day or 300 mg/month (67-75% of the standard maximum dose of aripiprazole).

Literature:

6. SPC’s Abilify, Abilify Maintena, Abilify (USA), Aristad (USA).

Date 14-05-2018

CYP2D6 UM: aripiprazol

NO action is needed for this gene-drug interaction.

The genetic variation decreases the plasma concentration of the sum of aripiprazole and the active metabolite dehydroaripiprazole to a limited degree. There is no evidence that this increases the risk of reduced effectiveness.

Literature:


Date 14-05-2018

CYP2D6 IM: atenolol

This is NOT a gene-drug interaction.

Literature:

CYP2D6 PM: atenolol

This is NOT a gene-drug interaction.

Literature:


CYP2D6 UM: atenolol

This is NOT a gene-drug interaction.

Literature:

-  

CYP2D6 IM: atomoxetine

The genetic variation increases the plasma concentration of atomoxetine and can thereby reduce the dose requirement.

Recommendation:

1. in the event of side effects occurring and/or a response later than 9 weeks: reduce the dose and check whether the effect is conserved
   The plasma concentration of atomoxetine is a factor of 2-3 times higher for IM than for EM at the same dose.

Literature:

CYP2D6 PM: atomoxetine

The genetic variation increases the plasma concentration of atomoxetine and thereby the risk of side effects.

Recommendation:

1. start with the normal initial dose, bearing in mind that an increase in this dose probably will not be required
2. advise the patient to seek contact if side effects occur (such as decreased appetite, vomiting, abdominal pain, constipation, insomnia, early waking, drowsiness, pupil dilation and itching)
3. if the medicine is effective, but side effects occur: reduce the dose and check whether the effect is conserved

The plasma concentration of atomoxetine is a factor of 8-11 times higher for PM than for EM at the same dose.

Literature:

9. SPC’s Strattera (NL en VS).

Date 31-10-2016

CYP2D6 UM: atomoxetine

The genetic variation results in an increased conversion of atomoxetine to the active metabolite 4-hydroxyatomoxetine, which has a much lower plasma concentration. As the plasma concentration of the active ingredients decreases as a result, this gene variation can result in reduced efficacy.

Recommendation:

1. be extra alert to reduced efficacy of the treatment
2. advise the patient to contact their doctor in the event of inadequate effect
3. an alternative can be selected as a precaution
   Clonidine is not metabolised by CYP2D6.

Literature:

The genetic polymorphism may lead to reduced atorvastatin transport to the liver. This may increase atorvastatin plasma concentrations and therefore the risk of myopathy.

Recommendation:

- **Patient has ADDITIONAL SIGNIFICANT RISK FACTORS for statin-induced myopathy:**
  1. Choose an alternative
     - Rosuvastatin and pravastatin are influenced to a similar extent by SLCO1B1 polymorphisms but are not influenced by CYP3A4 inhibitors such as amiodarone, verapamil and diltiazem.
     - Fluvastatin is not influenced by SLCO1B1 polymorphisms or CYP3A4 inhibitors.
  2. If an alternative is not an option: advise the patient to contact their doctor in the event of muscle symptoms.

- **Patient has NO additional significant risk factors for statin-induced myopathy:**
  1. Advise the patient to contact their doctor in the event of muscle symptoms.

Literature:

Fluvastatin is not influenced by SLCO1B1 polymorphisms or CYP3A4 inhibitors.

2. If an alternative is not an option: advise the patient to contact their doctor in the event of muscle symptoms.

- Patient has NO additional significant risk factors for statin-induced myopathy:
  1. Advise the patient to contact their doctor in the event of muscle symptoms.

Literature:


Date 27-11-2012

NUDT15 IM: azathioprine/mercaptopurine

Grade ≥ 2 leukopaenia occurs in 42% of these patients with standard therapy. The genetic variation increases the concentration of the fully activated metabolite of azathioprine and mercaptopurine.

- IMMUNOSUPPRESSION:
  - start with 50% of the standard dose
    Adjustment of the initial dose should be performed based on toxicity (monitoring of the blood counts) and efficacy. Monitoring should be performed at an increased frequency.
    Note: The percentage of 50% is based on the analogy with TPMT, for which the gene variants have a comparable effect on toxicity to those of NUDT15. A percentage of < 70% was calculated for NUDT15, but there were insufficient data available to calculate the exact percentage.
    Note: Dose adjustment based on the total of 6-TGN metabolites is not possible for these patients, as they develop toxicity within the therapeutic range that applies for patients without gene variants.

- LEUKAEMIA:
  - start at 50% of the standard mercaptopurine dose, or start with the standard dose and reduce to 50% if side effects necessitate a dose reduction
    It is not known whether dose reduction in advance results in the same efficacy as dose reduction based on toxicity. Adjustment of the initial dose should be performed based on toxicity (monitoring of the blood counts) and efficacy. Monitoring should be performed at an increased frequency.
    Note: The percentage of 50% is based on the analogy with TPMT, for which the gene variants have a comparable effect on toxicity to those of NUDT15. A percentage of < 70% was calculated for NUDT15, but there were insufficient data available to calculate the exact percentage.
    Note: Dose adjustment based on the total of 6-TGN metabolites is not possible for these patients, as they develop toxicity within the therapeutic range that applies for patients without gene variants.

Note: more stringent dose reductions are necessary if the patient is also TPMT IM.
NUDT15 PM: azathioprine/mercaptopurine

Grade ≥ 2 leukopenia occurs in 96% of these patients with standard therapy. The genetic variation increases the concentration of the fully activated metabolite of azathioprine and mercaptopurine.

- avoid azathioprine and mercaptopurine
- if it is not possible to avoid azathioprine and mercaptopurine: use 10% of the standard dose and advise patients to seek medical attention when symptoms of myelosuppression (such as severe sore throat in combination with fever, regular nosebleeds and tendency to bruising) occur
  Any adjustment of the initial dose should be guided by toxicity (monitoring of blood counts) and efficacy. Monitoring should be performed at an increased frequency.
  Note: The percentage of 10% is based on the analogy with TPMT, for which the gene variants have a comparable effect on toxicity to those of NUDT15. A percentage of < 20% was calculated for NUDT15 PM, but there were insufficient data available to calculate the exact percentage.
  Note: Dose adjustment based on the total of 6-TGN metabolites is not possible for these patients, as they develop toxicity within the therapeudic range that applies for patients without gene variants.

Literature:

12. SmPC’s Puri-Nethol en Imuran.

Date 04-03-2019

TPMT IM: azathioprine/mercaptopurine

The genetic variation reduces the conversion of azathioprine and mercaptopurine to mainly inactive metabolites. This increases the risk of serious, life-threatening adverse events such as myelosuppression.

Recommendation:

- **IMMUNOSUPPRESSION**
  - Start with 50% of the standard dose
  - Adjustment of the initial dose should be guided by toxicity (monitoring of blood counts) and effectiveness.
  - The frequency of monitoring should be increased.
  - Dose adjustment is not required for doses lower than 1.5 mg/kg per day for azathioprine or 0.75 mg/kg per day for mercaptopurine.

- **LEUKAEMIA:**
  - start with 50% of the standard mercaptopurine dose, or start with the standard dose and reduce to 50% if side effects necessitate a dose reduction
  - It is not known whether dose reduction in advance results in the same efficacy as dose reduction based on toxicity.
  - The initial dose should be adjusted based on toxicity (monitoring of the blood counts) and efficacy.
  - Monitoring should be performed at an increased frequency.

Note: more stringent dose reductions are necessary if the patient is also NUDT15 IM.

Literature:


Date 04-03-2019

TPMT PM: azathioprine/mercaptopurine

The genetic variation reduces the conversion of azathioprine and mercaptopurine to mainly inactive metabolites. This increases the risk of serious, life-threatening adverse events such as myelosuppression.

Recommendation:

1. Choose an alternative or start with 10% of the standard dose.
   Any adjustment of the initial dose should be guided by toxicity (monitoring of blood counts) and effectiveness.
   The frequency of monitoring should be increased.
2. If the dose is decreased: advise patients to seek medical attention when symptoms of myelosuppression (such as severe sore throat in combination with fever, regular nosebleeds and tendency to bruising) occur

Literature:

5. Levinsen M et al. Pharmacogenetically based dosing of thiopurines in childhood acute lymphoblastic leukaemia: influence on cure
28. SPC’s Imuran en Puri-Nethol.

Date 27-05-2015

CYP2D6 IM: bisoprolol

This is NOT a gene-drug interaction.

Literature:

Date 26-05-2009
CYP2D6 PM: bisoprolol

This is NOT a gene-drug interaction.

Literature:
1. Deroubaix X et al. Comparative bioavailability of a metoprolol controlled release formulation and a bisoprolol normal release tablet after single oral dose administration in healthy volunteers.

Date 26-05-2009

CYP2D6 UM: bisoprolol

This is NOT a gene-drug interaction.

Literature:
-

Date 26-05-2009

CYP2D6 IM: brexpiprazol

NO action is required for this gene-drug interaction.

There are indications supporting an increase in the exposure to brexpiprazole, but no indications supporting an increase in side effects in patients with this gene variation.

Literature:
2. EPAR Rxulti.

Date 13-05-2019

CYP2D6 PM: brexpiprazol

The risk of side effects is theoretically increased, because the gene variation reduces the metabolism of brexpiprazole.

- use half of the standard dose

Literature:
1. SmPC en EPAR Rxulti en SmPC Rexulti (VS).
CYP2D6 UM: brexpiprazol

NO action is required for this gene-drug interaction.

The gene variation results in a reduction of the exposure to brexpiprazole, but there are no indications supporting a decrease in efficacy.

Literature:

1. EPAR Rxulti.

CYP2D6 IM: carvedilol

NO action is required for this gene-drug interaction.

The plasma concentration of carvedilol can be elevated. This does not, however, result in an increase in side effects.

Literature:


CYP2D6 PM: carvedilol

NO action is required for this gene-drug interaction.

The plasma concentration of carvedilol can be elevated. This does not, however, result in an increase in side effects.
Literature:


Date 24-08-2016

CYP2D6 UM: carvedilol

NO action is required for this gene-drug interaction.

The plasma concentration of carvedilol can be reduced. This does not, however, result in a decrease in the effectiveness.

Literature:


Date 24-08-2016

CYP2C19 IM: citalopram

The risk of QT prolongation and torsades de pointes is theoretically increased because the gene variation leads to an increased citalopram plasma concentration. If you follow the dose recommendation below, the increased plasma concentration and the theoretically increased risk of QT prolongation will be offset.

- Do not exceed the following daily doses:
  1. adults up to 65 years: 30 mg as tablets or 22 mg as drops
  2. adults 65 years or older: 15 mg as tablets or 10 mg as drops

Literature:

CYP2C19 PM: citalopram

The risk of QT prolongation and therefore also the theoretical risk of torsades de pointes is increased as the gene variation leads to an increased citalopram plasma concentration. If you follow the dose recommendation below, the increased plasma concentration and the increased risk of QT prolongation will be offset.

- do not exceed the following daily doses (50% of the standard maximum dose):
  1. adults up to 65 years: 20 mg as tablets or 16 mg as drops
  2. adults 65 years or older: 10 mg as tablets or 8 mg as drops

Literature:


CYP2C19 UM: citalopram

NO action is needed for this gene-drug interaction.

The gene variation increases conversion of citalopram to a weakly active metabolite. However, there is no significant effect on the
plasma concentration of citalopram, the tolerance or the response.

Literature:


Date 14-05-2018

CYP2D6 IM: citalopram/escitalopram

This is NOT a gene-drug interaction.

Literature:

10. SPC Cipramil.

Date 14-05-2018

CYP2D6 PM: citalopram/escitalopram

This is NOT a gene-drug interaction.

Literature:

2. de Vos A et al. Association between CYP2C19*17 and metabolism of amitriptyline, citalopram and clomipramine in Dutch
9. SPC’s Cipramil, Lexapro (NL en VS) en Celexa (VS).

Date 14-05-2018

CYP2D6 UM: citalopram/escitalopram

This is NOT a gene-drug interaction.

Literature:

5. SPC Cipramil.

Date 04-03-2019

CYP2C19 IM: clomipramine

NO action is required for this gene-drug interaction.

The gene variation does increase clomipramine plasma concentrations, but not clomipramine+desmethylclomipramine plasma concentrations, which determines side effects and efficacy in depression. The increase in the plasma concentration of clomipramine is favourable for the efficacy in anxiety and obsessive compulsive disorder.

Literature:


Date 04-03-2019

CYP2C19 PM: clomipramine
NO action is required for this gene-drug interaction.

The gene variation increases the plasma concentration of clomipramine. However, there is insufficient evidence to substantiate an increase of the plasma concentration of clomipramine+desmethylclomipramine to such an extent that it increases the risk of side effects. The increase in the plasma concentration of clomipramine is favourable for the efficacy in anxiety and obsessive compulsive disorder.

Literature:


Date 04-03-2019

CYP2C19 UM: clomipramine

The gene variation increases the risk of ineffectiveness for obsessive compulsive disorder and anxiety disorders by reducing the plasma concentration of clomipramine. The gene variation has little to no effect on the plasma concentration of clomipramine+desmethylclomipramine, which determines the efficacy for depression and side effects.

- Indication OBSESSIVE COMPULSIVE DISORDER or ANXIETY DISORDERS:
  - avoid clomipramine
    Antidepressants that are not metabolised by CYP2C19 - or to a lesser extent - include, for example, fluoxetine, fluvoxamine and paroxetine.
  - if it is not possible to avoid clomipramine:
    - monitor the effect and side effects or the plasma concentrations of clomipramine and desmethylclomipramine
      For obsessive compulsive disorder, the therapeutic plasma concentration of clomipramine is greater than 200 ng/mL in combination with a plasma concentration of desmethylclomipramine that is as low as possible.
      For anxiety disorders, the therapeutic plasma concentration of clomipramine is approximately 100 ng/mL in combination with a plasma concentration of desmethylclomipramine lower than 200 ng/mL.
      A sum of the plasma concentrations of clomipramine and desmethylclomipramine exceeding 600 ng/mL is considered toxic.
    - add a low dose of fluvoxamine if necessary, to inhibit CYP2C19 and CYP1A2 and thereby inhibit the conversion of clomipramine to desmethylclomipramine

- Indication DEPRESSION:
  - no action required

Literature:


Date 04-03-2019

CYP2D6 IM: clomipramine

The risk of side effects may be increased, because the gene variation leads to increased plasma concentrations of clomipramine and the active metabolite desmethylclomipramine.

- use 70% of the standard dose and monitor the effect and side effects or the plasma concentrations of clomipramine and desmethylclomipramine
  For depression, the therapeutic range is 200-400 ng/mL for the sum of the plasma concentrations of clomipramine and desmethylclomipramine.
For anxiety disorders, the therapeutic plasma concentration of clomipramine is approximately 100 ng/mL, in combination with a plasma concentration of desmethylclomipramine lower than 200 ng/mL. For obsessive compulsive disorder, the therapeutic plasma concentration of clomipramine is higher than 200 ng/mL, in combination with a plasma concentration of desmethylclomipramine that is as low as possible. A sum of the plasma concentrations of clomipramine and desmethylclomipramine higher than 600 ng/mL is considered toxic.

Literature:


Date 19-11-2018

CYP2D6 PM: clomipramine

The risk of side effects may be increased, because the gene variation leads to increased plasma concentrations of clomipramine and the active metabolite desmethylclomipramine.

- **Indication DEPRESSION:**
  - use 50% of the standard dose and monitor the effect and side effects or the plasma concentrations of clomipramine and desmethylclomipramine in order to set the maintenance dose.
  - The therapeutic range is 200-400 ng/mL for the sum of the plasma concentrations of clomipramine and desmethylclomipramine. Values higher than 600 ng/mL are considered toxic.

- **Indication ANXIETY DISORDERS or OBSESSIVE COMPULSIVE DISORDER:**
  - if side effects occur: use 50% of the standard dose and monitor the effect and side effects or the plasma concentrations of clomipramine and desmethylclomipramine in order to set the maintenance dose.
  - It is not known whether it is possible to reduce the dose to such an extent that the side effects disappear while the effectiveness is retained. Clomipramine and desmethylclomipramine both contribute to the side effects. Only clomipramine contributes to the effectiveness.
  - For anxiety disorders, the therapeutic plasma concentration of clomipramine is approximately 100 ng/mL, in combination with a plasma concentration of desmethylclomipramine lower than 200 ng/mL.
  - For obsessive compulsive disorder, the therapeutic plasma concentration of clomipramine is higher than 200 ng/mL, in combination with a plasma concentration of desmethylclomipramine that is as low as possible.
  - A sum of the plasma concentrations of clomipramine and desmethylclomipramine higher than 600 ng/mL is considered toxic, whilst the therapeutic upper limit for depression is 400 ng/mL.
  - if dose reduction does not have the desired effect: avoid clomipramine

Antidepressants that are not metabolised by CYP2D6, or to a lesser extent, include citalopram and sertraline.

Literature:

The risk of ineffectiveness and cardiotoxic side effects may be increased. The gene variation leads to reduced plasma concentrations of clomipramine and the active metabolite desmethylclomipramine and to increased concentrations of the potentially cardiotoxic hydroxy metabolites.

- use 1.5 times the standard dose and monitor the effect and side effects of the plasma concentrations of clomipramine and desmethylclomipramine to set the maintenance dose.
  For depression, the therapeutic range is 200-400 ng/mL for the sum of the plasma concentrations of clomipramine and desmethylclomipramine.
  For anxiety disorders, the therapeutic plasma concentration of clomipramine is approximately 100 ng/mL, in combination with a plasma concentration of desmethylclomipramine lower than 200 ng/mL.
  For obsessive compulsive disorder, the therapeutic plasma concentration of clomipramine is higher than 200 ng/mL, in combination with a plasma concentration of desmethylclomipramine that is as low as possible.
- if a dose increase is not wanted due to potential cardiotoxic hydroxy metabolites: avoid clomipramine.

Antidepressants that are not metabolised by CYP2D6, or to a lesser extent, include citalopram and sertraline.

Literature:

CYP2D6 PM: clonidine

This is NOT a gene-drug interaction.

Literature:
-

Date 24-08-2016

CYP2D6 UM: clonidine

This is NOT a gene-drug interaction.

Literature:
-

Date 24-08-2016

CYP2C19 IM: clopidogrel

The risk of serious cardiovascular and cerebrovascular events is increased in patients undergoing balloon angioplasty or stent placement (percutaneous coronary intervention) and in patients with a stroke or TIA, as the genetic variation reduces the activation of clopidogrel. No negative clinical consequences have been observed in other patients.

- PERCUTANEOUS CORONARY INTERVENTION, STROKE or TIA:
  - choose an alternative or double the dose to 150 mg/day (600 mg loading dose)
  - Prasugrel, ticagrelor and acetylsalicylic acid/dipyridamole are not metabolised by CYP2C19 (or to a lesser extent).
- OTHER INDICATIONS:
  - no action required

Literature:


CYP2C19 PM: clopidogrel

The risk of serious cardiovascular and cerebrovascular events is increased in patients undergoing balloon angioplasty or stent placement (percutaneous coronary intervention) and in patients with a stroke or TIA, because the genetic variation reduces the activation of clopidogrel. No negative clinical consequences have been proved in other patients.

- PERCutaneous coronary intervention, STROKE or TIA:
  - avoid clopidogrel
  - Prasugrel, ticagrelor and acetylsalicylic acid/dipyridamole are not metabolised by CYP2C19 (or to a lesser extent).

- OTHER INDICATIONS:
  - determine the level of inhibition of platelet aggregation by clopidogrel
  - consider an alternative in poor responders
  - Prasugrel and ticagrelor are not metabolised by CYP2C19 (or to a lesser extent).

Literature:

22. Bonello-Palot N et al. Relation of body mass index to high on-treatment platelet reactivity and of failed clopidogrel dose


31. FDA Drug Safety Communication: Reduced effectiveness of Plavix (clopidogrel) in patients who are poor metabolizers of the drug. 03-12-10.

32. SPC’s Clopidogrel Sandoz en Plavix (VS).


Date 19-11-2018

**CYP2C19 UM: clopidogrel**

NO action is required for this gene-drug interaction.

The genetic variation results in increased conversion of clopidogrel to the active metabolite. However, this can result in both positive effects (reduction in the risk of serious cardiovascular and cerebrovascular events) and negative effects (increase in the risk of bleeding).

**Literature:**


**CYP2D6 IM: clozapine**

This is NOT a gene-drug interaction.

**Literature:**


**CYP2D6 PM: clozapine**

This is NOT a gene-drug interaction.

**Literature:**

CYP2D6 UM: clozapine

This is NOT a gene-drug interaction.

Literature:


Date 25-05-2016

CYP2D6 IM: codeine

The genetic variation reduces the conversion of codeine to morphine. This can result in reduced analgesia.

Recommendation:

- For COUGH:
  1. no action required
- For PAIN:
  It is not possible to offer adequately substantiated advice for dose adjustment based on the limited available literature for this phenotype.
  1. be alert to a reduced effectiveness
  2. in the case of inadequate effectiveness:
     1. try a dose increase
     2. if this does not work: choose an alternative
        Do not select tramadol, as this is also metabolised by CYP2D6
        Morphine is not metabolised by CYP2D6.
        Oxycodone is metabolised by CYP2D6 to a limited extent, but this does not result in differences in analgesia in patients.
  3. if no alternative is selected: advise the patient to report inadequate analgesia

Literature:

7. SPC Codeïnefosfaat Ratiopharm.

Date 20-11-2017

CYP2D6 PM: codeine
The genetic variation reduces the conversion of codeine to morphine. This can result in reduced analgesia.

Recommendation:

- For COUGH:
  1. no action required
- For PAIN:
  It is not possible to offer adequately substantiated advice for dose adjustment based on the limited available literature for this phenotype.
  1. choose an alternative
     Do not select tramadol, as this is also metabolised by CYP2D6
     Morphine is not metabolised by CYP2D6.
     Oxycodone is metabolised by CYP2D6 to a limited extent, but this does not result in differences in analgesia in patients.
  2. if an alternative is not an option: advise the patient to report inadequate analgesia.

Literature:

17. SPC Codeinefosfaat Ratiopharm.

Date 20-11-2017

CYP2D6 UM: codeine

The genetic variation increases the conversion of codeine to morphine. This can result in an increase in side effects. Death has occurred in children who received analgesic doses. One adult with reduced kidney function and co-medication with two CYP3A4 inhibitors became comatose after use of codeine for a cough.

Recommendation:

- DOSES HIGHER THAN 20 mg every 6 hours for adults and 10 mg every 6 hours for children aged 12 years or older AND/OR ADDITIONAL RISK FACTORS, such as co-medication with CYP3A4 inhibitors and/or reduced kidney function:
  Codeine is contra-indicated
  - if possible, select an alternative
For PAIN: do not select tramadol, as this is also metabolised by CYP2D6. Morphine is not metabolised by CYP2D6. Oxycodone is metabolised by CYP2D6 to a limited extent, but this does not result in differences in side effects in patients.

For COUGH: noscapine is not metabolised by CYP2D6.

- DOSES LOWER THAN OR EQUAL TO 20 mg every 6 hours for adults and 10 mg every 6 hours for children aged 12 years or older AND NO ADDITIONAL RISK FACTORS, such as co-medication with CYP3A4 inhibitors and/or reduced kidney function:
  - no action required

Literature:

15. SPC Codeïnefosfaat Ratiopharm.
16. SPC Codeine Sulfate Tablets (VS).

Date 20-11-2017

CYP2D6 IM: disopyramide

This is NOT a gene-drug interaction.

Literature:


Date 24-08-2016

CYP2D6 PM: disopyramide

This is NOT a gene-drug interaction.
**CYP2D6 UM: disopyramide**

This is NOT a gene-drug interaction.

**CYP2C19 IM: doxepine**

NO action is required for this gene-drug interaction.

The gene variation has an effect on the exposure to doxepin, but not on the exposure to doxepin + the active metabolite nordoxepin, which determines the effect and side effects.

**Literature:**


**CYP2C19 PM: doxepine**

NO action is required for this gene-drug interaction.

The gene variation has an effect on the exposure to doxepin, but not on the exposure to doxepin + the active metabolite nordoxepin, which determines the effect and side effects.

**Literature:**

2. SmPC Silenor (VS).

**CYP2C19 UM: doxepine**

NO action is required for this gene-drug interaction.
The gene variations have an effect on the exposure to doxepin, but not on the exposure to doxepin + the active metabolite nordoxepin, which determines the effect and side effects.

Literature:


Date 04-03-2019

**CYP2D6 IM: doxepine**

2015

The risk of side effects may be increased, because the gene variation leads to increased plasma concentrations of doxepin and the active metabolite nordoxepin.

- use 80% of the standard dose and monitor the effect and side effects or the plasma concentrations of doxepin and nordoxepin in order to set the maintenance dose
  The therapeutic range is 100-250 ng/mL for the sum of doxepin and nordoxepin plasma concentrations. Values higher than 400 ng/mL are considered toxic.

Literature:


Date 19-11-2018

**CYP2D6 PM: doxepine**

2016

The risk of side effects may be increased, because the gene variation leads to increased plasma concentrations of doxepin and the active metabolite nordoxepin.

- use 40% of the standard dose and monitor the effect and side effects or the plasma concentrations of doxepin and nordoxepin in order to set the maintenance dose
  The therapeutic range is 100-250 ng/mL for the sum of doxepin and nordoxepin plasma concentrations. Values higher than 400 ng/mL are considered toxic.

Literature:

6. SmPC Silenor (VS).
**CYP2D6 UM: doxepine**

The risk of ineffectiveness and cardiotoxic side effects may be increased. The gene variation leads to reduced plasma concentrations of doxepin and the active metabolite nordoxepin and an increase in the plasma concentrations of the potentially cardiotoxic hydroxy metabolites.

- double the standard dose and monitor the effect and side effects or the plasma concentrations of doxepin and nordoxepin in order to set the maintenance dose
  
  The therapeutic range is 100-250 ng/mL for the sum of doxepin and nordoxepin plasma concentrations. Values higher than 400 ng/mL are considered toxic.
- if a dose increase is not wanted due to the potentially cardiotoxic hydroxy metabolites: avoid doxepin.
  
  Antidepressants that are not metabolised by CYP2D6, or to a lesser extent, include citalopram and sertraline.

**Literature:**


Date 19-11-2018

---

**CYP2D6 IM: duloxetine**

This is NOT a gene-drug interaction.

**Literature:**


Date 30-01-2017

---

**CYP2D6 PM: duloxetine**

This is NOT a gene-drug interaction.

**Literature:**

3. SPC Cymbalta.
CYP2D6 UM: duloxetine

This is NOT a gene-drug interaction.

Literature:


CYP2B6 IM: efavirenz

Genetic variations increase the efavirenz plasma concentration and therefore the risk of side effects. However, the efavirenz plasma concentration remains within the therapeutic range for the majority of patients.

Recommendation:

1. Determine the efavirenz plasma concentration if side effects occur and reduce the dose if needed.
   In 14 IM adults, a dose reduction to 400 mg/day (2/3rd of the standard dose) was sufficient to achieve therapeutic plasma concentrations and to reduce or resolve side effects.
   The therapeutic range established for efavirenz is 1000-4000 ng/ml.

Literature:

CYP2B6 PM: efavirenz

Genetic variations increase the risk of side effects. The standard dose leads to an efavirenz concentration in the toxic range in the majority of patients with this genotype.

Recommendation:

- Efavirenz in MONOpreparation, adults and children FROM 40 KG:
  - Body mass index LESS THAN or EQUAL to 25:
    1. The recommended initial dose is 400 mg/day and this dose should be titrated to plasma concentration if needed (further reduction to 200 mg/day or in rare cases an increase to 600 mg/day).
    The therapeutic range established for efavirenz is 1000-4000 ng/ml.
  - Body mass index GREATER than 25:
    1. The recommended initial dose is 600 mg/day and this dose should be titrated to plasma concentration if needed (reduction to 400 or 200 mg/day).
    The therapeutic range established for efavirenz is 1000-4000 ng/ml.

- Efavirenz in MONOpreparation, children LIGHTER THAN 40 KG:
  1. Start with the standard dose and titrate this dose to plasma concentration if needed. In adults, therapeutic plasma concentrations were achieved at either 2/3rd of the standard dose (1/3rd of the patients) or 1/3rd of the standard dose (2/3rd of the patients). In children younger than 3 years, therapeutic plasma concentrations were achieved at doses of approximately 10 mg/kg per day (as capsules) (100 mg/day for 7-14 kg and 150 mg/day for 14-17 kg; 50-75% of the standard dose).
    The therapeutic range established for efavirenz is 1000-4000 ng/ml.

- Efavirenz in COMBINATION preparation:
  1. Initiate the combination preparation and titrate the efavirenz dose to plasma concentration if needed (reduction to 400 or 200 mg/day)
    The therapeutic range established for efavirenz is 1000-4000 ng/ml.

Note: the dosing recommendations above are based on PM patients with the *6/*6 genotype. There is evidence that the *18/*18 genotype in PM patients (only present in negroid patients) may require greater dose reductions.

Considerations:

Detailed justification for the recommendation is contained in the risk analysis. The considerations used for adults are also given below. The median or mean plasma concentrations or AUC in PM patients are above the therapeutic range, except in 3 studies with low efavirenz plasma concentrations in EM patients (2 of the 3 studies performed in Africa and 1 study in the United States and Italy). A recent study showed a similar virological response for efavirenz 400 and 600 mg/day in patients not selected on genotype. The risk of underdose is therefore very small if the initial dose is reduced to 400 mg/day. Two small studies showed that dose reductions did not reduce the efficacy (HIV remained undetectable), but side effects did reduce in 24 PM patients.

Compliance improves with administration of a combination preparation and the absence of unnecessary side effects due to excessive plasma concentrations.

Consideration to CYP2B6 inducers such as rifampicin is not needed in PM patients. The significantly low or absent metabolic capacity of CYP2B6 makes induction of little to no relevance. Moreover, the effects of enzyme induction by rifampicin and enzyme inhibition by isoniazid on efavirenz plasma concentrations seem to largely cancel each other out, independent of the CYP2B6 phenotype of the patient.

Literature:

5. Dickinson L et al. Comprehensive pharmacokinetic, pharmacodynamic and pharmacogenetic evaluation of once-daily efavirenz


19. SPC’s Efavirenz Mylan en Sustiva (VS).

**CYP2D6 IM: eliglustat**

This gene variation reduces the conversion of eliglustat to inactive metabolites. However, in the absence of CYP2D6 and CYP3A inhibitors, this does not result in a clinically significant increased risk of side effects.

**Recommendation:**

- Co-medication with BOTH a MODERATE to STRONG CYP2D6 INHIBITOR AND a MODERATE to STRONG CYP3A INHIBITOR:
  
  Eliglustat is contra-indicated.
  
  - choose an alternative if possible
    
    Strong CYP2D6 inhibitor: for example paroxetine, fluoxetine, quinidine, bupropione.
    
    Moderate CYP2D6 inhibitor: for example duloxetine, terbinafine, mocllobemide, mirabegron, cinacalcet, dronedarone.
    
    Strong CYP3A inhibitor: for example ketoconazole, clarithromycin, itraconazole, cobicistat, indinavir, lopinavir, ritonavir, saquinavir, telaprevir, tipranavir, posaconazole, voriconazole, telithromycin, conivaptan, boceprevir.
    
    Moderate CYP3A inhibitor: for example erythromycin, ciprofloxacin, fluconazole, diltiazem, verapamil, aprepitant, atazanavir, darunavir, fosamprenavir, imatinib, cimetidine.

- Co-medication with a STRONG CYP2D6 INHIBITOR (e.g. paroxetine, fluoxetine, quinidine, bupropione):
  
  - use a dose of 84 mg eliglustat 1x daily
  
- Co-medication with a MODERATE CYP2D6 INHIBITOR (for example duloxetine, terbinafine, mocllobemide, mirabegron, cinacalcet, dronedarone):
  
  - consider a dose of 84 mg eliglustat 1x daily
  - be alert to side effects

- Co-medication with a STRONG CYP3A INHIBITOR (for example ketoconazole, clarithromycin, itraconazole, cobicistat, indinavir, lopinavir, ritonavir, saquinavir, telaprevir, tipranavir, posaconazole, voriconazole, telithromycin, conivaptan, boceprevir):
  
  - choose an alternative if possible
  - if an alternative is not an option:

Date 05-03-2018

**CYP2D6 IM: eliglustat**

6138
- consider a dose of 84 mg eliglustat 1x daily
- be alert to side effects

- Co-medication with a MODERATE CYP3A INHIBITOR (for example erythromycin, ciprofloxacin, fluconazole, diltiazem, verapamil, aprepitant, atazanavir, darunavir, fosamprenavir, imatinib, cimetidine):
  1. choose an alternative
  2. if an alternative is not an option:
     1. consider a dose of 84 mg eliglustat 1x daily
     2. be alert to side effects

- Co-medication with a STRONG CYP3A INHIBITOR (for example clarithromycin, itraconazole, cobicistat, indinavir, lopinavir, ritonavir, saquinavir, telaprevir, tipranavir, posaconazole, voriconazole, telithromycin, conivaptan, boceprevir):
  Eliglustat is contra-indicated.
  1. choose an alternative if possible

- Co-medication with a MODERATE CYP3A INHIBITOR (for example erythromycin, ciprofloxacin, fluconazole, diltiazem, verapamil, aprepitant, atazanavir, darunavir, fosamprenavir, imatinib, cimetidine):
  Eliglustat is not recommended. The plasma concentration may decrease so sharply that a therapeutic effect cannot be achieved.
  1. choose an alternative if possible

- NO co-medication with a moderate or strong CYP2D6 or CYP3A inhibitor or strong CYP3A inducer:
  1. use the standard dose of 84 mg 2x daily

Literature:
1. SPC’s Cerdelga (Nederland en VS).

Date 31-10-2016

**CYP2D6 PM: eliglustat**

6137

This gene variation reduces the conversion of eliglustat to inactive metabolites. This increases the risk of side effects, such as a (small, dose-dependent) elongation of the QT interval. CYP3A inhibitors increase this risk even further.

Recommendation:

- Co-medication with a STRONG CYP3A INHIBITOR (for example ketoconazole, clarithromycin, itraconazole, cobicistat, indinavir, lopinavir, ritonavir, saquinavir, telaprevir, tipranavir, posaconazole, voriconazole, telithromycin, conivaptan, boceprevir):
  Eliglustat is contra-indicated.
  1. choose an alternative if possible

- Co-medication with a MODERATE CYP3A INHIBITOR (for example erythromycin, ciprofloxacin, fluconazole, diltiazem, verapamil, aprepitant, atazanavir, darunavir, fosamprenavir, imatinib, cimetidine):
  Eliglustat is not recommended.
  1. choose an alternative if possible

- Co-medication with a WEAK CYP3A INHIBITOR (for example amlopidine, cilostazole, fluvoxamine, goldenseal, isoniazide, ranitidine, ranolazine):
  1. choose an alternative for the weak CYP3A inhibitor if possible
  2. if an alternative is not an option:
     1. use a dose of 84 mg eliglustat 1x daily
     2. be alert to side effects

- Co-medication with a STRONG CYP3A INDUCER (for example rifampicin, carbamazepine, phenobarbital, phenytoin, rifabutine, hypericum):
  Eliglustat is not recommended. The plasma concentration may decrease so sharply that a therapeutic effect cannot be achieved.
  1. choose an alternative if possible

- NO co-medication with a CYP3A inhibitor or strong CYP3A inducer:
  1. use a dose of 84 mg 1x daily

Literature:
1. SPC’s Cerdelga (Nederland en VS).

Date 31-10-2016
CYP2D6 UM: eliglustat

This gene variation increases the conversion of eliglustat to inactive metabolites. As a result, a normal dose is not effective. There is not enough scientific substantiation to suggest an effective dose for all UM.

Recommendation:

Eliglustat is contra-indicated.
1. choose an alternative if possible

Literature:
1. SPC’s Cerdelga (Nederland en VS).

Date 31-10-2016

CYP2C19 IM: escitalopram

The risk of QT prolongation and torsades de pointes is theoretically increased because the gene variation leads to an increased escitalopram plasma concentration. If you follow the dose recommendation below, the increased plasma concentration and the theoretically increased risk of QT prolongation will be offset.

- Do not exceed the following doses (75% of the standard maximum dose):
  adults < 65 years 15 mg/day, ≥65 years 7.5 mg/day

Literature:
CYP2C19 PM: escitalopram

The risk of conversion to another antidepressant is increased. In addition, the risk of QT prolongation and torsades de pointes is theoretically increased because the gene variation leads to an increased escitalopram plasma concentration. If you follow the dose recommendation below, the increased plasma concentration, the theoretically increased risk of QT prolongation and the increased risk of conversion to another antidepressant will be offset.

- Do not exceed the following doses (50% of the standard maximum dose):
  - adults < 65 years 10 mg/day, ≥65 years 5 mg/day

Literature:

17. SPC’s Lexapro (NL en VS).

CYP2C19 UM: escitalopram

The risk of conversion to another antidepressant is increased as the gene variation leads to a reduction in the escitalopram plasma concentration.

- avoid escitalopram
  - Antidepressants that are not metabolised or that are metabolised to a lesser extent by CYP2C19 are, for example, paroxetine or fluvoxamine.
Literature:


Date 14-05-2018

**CYP2C19 IM: esomeprazol**

NO action is needed for this gene-drug interaction.

Although the genetic variation leads to a higher plasma concentration of esomeprazole, there is insufficient evidence to support an effect on the therapeutic effectiveness and side effects.

Literature:

14. Sheu BS et al. Esomeprazole 40 mg twice daily in triple therapy and the efficacy of Helicobacter pylori eradication related to

Date 05-03-2018

CYP2C19 PM: esomeprazol

NO action is needed for this gene-drug interaction.

Although the genetic variation leads to a higher plasma concentration of esomeprazole, there is insufficient evidence to support an effect on the therapeutic effectiveness and side effects.

Literature:

14. SPC Nexium (Nederlands en Amerikaans).

Date 05-03-2018

CYP2C19 UM: esomeprazol

NO action is required for this gene-drug interaction.

Although the genetic variation may lead to faster inactivation of esomeprazole, there is insufficient evidence to support an effect on the therapeutic effectiveness and side effects.

Literature:

3. Hunfeld NG et al. A comparison of the acid-inhibitory effects of esomeprazole and pantoprazole in relation to pharmacokinetics
CYP2C9 IM: fenprocoumon

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

Literature:

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

Literature:


Date 14-05-2018

CYP2C9*1/*2: phenprocoumon

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

Literature:

Date 14-05-2018

**CYP2C9*1/*3: fenprocoumon**

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

**Literature:**


Date 14-05-2018

**CYP2C9*2/*2: fenprocoumon**

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose and possibly in an extension of the time required to achieve a stable INR. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

Literature:

CYP2C9*2/*3: fenprocoumon

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

Literature:

17. Visser LE et al. The risk of overanticoagulation in patients with cytochrome P450 CYP2C9*2 or CYP2C9*3 alleles on
acenocoumarol or phenprocoumon. Pharmacogenetics 2004;14:27-33.

Date 14-05-2018

CYP2C9*3/*3: fenprocoumon

NO action is required for this gene-drug interaction.

The genetic variation can result in a reduction in the required maintenance dose. However, there is not enough evidence to confirm that this causes problems with normal initiation of the therapy (i.e. frequent INR monitoring).

Literature:


Date 14-05-2018

VKORC1 -1639 AA: fenprocoumon

An INR ≥ 6, resulting in an increased risk of bleeding, occurs in 17% of these patients with standard regulation by the Anticoagulation Clinic. The genetic variation increases the sensitivity to phenprocoumon.

- Monitoring by a ANTICOAGULATION CLINIC:
  - recommend to use 50% of the standard initial dose
- NO monitoring by a anticoagulation clinic:
  - recommend to use 50% of the standard initial dose
  - recommend more frequent monitoring of the INR

For patients younger than 75 years, the initial dose and the maintenance dose can be calculated using an algorithm as found in EU-PACT: see https://www.knmp.nl/patientenzorg/medicatiebewaking/farmacogenetica for a calculation tool in the form of an Excel file. However, for patients aged 75 years and older, this algorithm increases the risk of an INR above the therapeutic range compared to an algorithm without gene variations. Therefore, use of this algorithm is not recommended for these patients.

Literature:


Date 10-09-2018

VKORC1 -1639 GA: fenprocoumon

NO action is needed for this gene-drug interaction.

The gene variation leads to a lower dose requirement, but regular monitoring of patients ensures that this does not lead to a distinct increase in the risk of bleeding.

Literature:


Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects.

Recommendation:

1. The loading dose does not need to be adjusted.
2. For the other doses, use 75% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or rash) occur.

Literature:

14. Ninomiya H et al. Genetic polymorphism of the CYP2C subfamily and excessive serum phenytoin concentration with central

Date 31-10-2016

CYP2C9 PM: fenytoine

Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects.

Recommendation:

1. The loading dose does not need to be adjusted.
2. For the other doses, use 40-50% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or rash) occur.

Literature:


Date 31-10-2016

CYP2C9*1/*2: fenytoine

Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects.

Recommendation:

1. The loading dose does not need to be adjusted.
2. For the other doses, use 75% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or rash) occur.

Literature:

10. Kerb R et al. The predictive value of MDR1, CYP2C9, and CYP2C19 polymorphisms for phenytoin plasma levels.
Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects. The life-threatening cutaneous side effects Stevens-Johnson Syndrome and toxic epidermal necrolysis may occur, especially in Asian patients.

Recommendation:
1. The loading dose does not need to be adjusted.
2. For the other doses, use 75% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or, especially in Asian patients, rash) occur.

Literature:
CYP2C9*2/*2: fenytoine

Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects.

Recommendation:

1. The loading dose does not need to be adjusted.
2. For the other doses, use 50% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or rash) occur.

Literature:


CYP2C9*2/*3: fenytoine

Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects.

Recommendation:

1. The loading dose does not need to be adjusted.
2. For the other doses, use 50% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or rash) occur.

Literature:

5. www.nvza.nl, TDM monografie voor fenytoïne.
CYP2C9*3/*3: fenytoine

Genetic variation reduces conversion of phenytoin to inactive metabolites. This increases the risk of side effects. The life-threatening cutaneous side effects Stevens-Johnson Syndrome and toxic epidermal necrolysis may occur, especially in Asian patients.

Recommendation:

1. The loading dose does not need to be adjusted.
2. For the other doses, use 40% of the standard dose and assess the dose based on effect and serum concentration after 7-10 days.
3. Advise the patient to get in touch if side effects (such as ataxia, nystagmus, slurred speech, sedation or, especially in Asian patients, rash) occur.

Literature:

15. www.nvza.nl, TDM monografie voor fenytoïne.

Date 31-10-2016

CYP2D6 IM: flecainide

The genetic variation reduces conversion of flecainide to inactive metabolites. This may increase the risk of side effects.

Recommendation:

- Indications other than diagnosis of Brugada syndrome:
  1. reduce the dose to 75% of the standard dose and record an ECG and monitor the plasma concentration
- Provocation test for diagnosis of Brugada syndrome:
  No action required.
  At a dose of 2.0 mg/kg body weight to a maximum of 150 mg, the response is better for patients with alleles that result in reduced activity.
  All 5 patients with these alleles and 20% of the patients with two fully active alleles exhibited a response within 30 minutes.

Literature:


Date 24-08-2016

CYP2D6 PM: flecainide

The genetic variation reduces conversion of flecainide to inactive metabolites. This increases the risk of side effects.

Recommendation:

1. reduce the dose to 50% of the standard dose and record an ECG and monitor the plasma concentration

Literature:


Date 24-08-2016

CYP2D6 UM: flecainide

The genetic variation increases conversion of flecainide to inactive metabolites. A higher dose is possibly required as a result.

Recommendation:

There are no data about the pharmacokinetics and/or the effects of flecainide in UM.

1. monitor the plasma concentration as a precaution and record an ECG or select an alternative

Examples of anti-arrhythmic drugs that are not metabolised via CYP2D6 (or to a lesser extent) include sotalol, disopyramide, quinidine and amiodarone.

Literature:
HLA-B*5701: fluocoxillin

HLA-B*5701-positive patients have an 80-fold elevated risk of fluocoxillin-induced liver injury. However, the incidence is low (1-2 per 1000 individuals).

Recommendation:

1. Regularly monitor the patient’s liver function
2. Choose an alternative if liver enzymes and/or bilirubin levels are elevated

Literature:

4. SmPC Floxapen.

CYP2D6 IM: flufenazine

This is NOT a gene-drug interaction.

Despite the fact that the SmPC for fluphenazine lists CYP2D6 as the metabolising enzyme, this cannot be substantiated by the available literature.

Literature:

1. SPC Anatensol decanoaat.

CYP2D6 PM: flufenazine

This is NOT a gene-drug interaction.

Despite the fact that the SmPC for fluphenazine lists CYP2D6 as the metabolising enzyme, this cannot be substantiated by the available literature.

Literature:

1. SPC Anatensol decanoaat.
This is NOT a gene-drug interaction.

Despite the fact that the SmPC for fluphenazine lists CYP2D6 as the metabolising enzyme, this cannot be substantiated by the available literature.

**Literature:**

1. SPC Anatensol decanoaat.

**DPD AS 0: fluorouracil cutaan**

The gene variation increases the risk of severe, potentially fatal toxicity. A reduced conversion of fluorouracil/capecitabine to inactive metabolites means that the normal dose is an overdose.

- avoid fluorouracil
  
  NOTE: If a patient has two different genetic variations that lead to a non-functional DPD enzyme (e.g. *2A and *13), this recommendation only applies if the variations are on a different allele. If both variations are on the same allele, this patient actually has a gene activity score 1, for which no increased risk of severe, potentially fatal toxicity has been found with cutaneous use. These two situations can only be distinguished by determining the enzyme activity (phenotyping). This recommendation only applies if the patient has virtually no enzyme activity.

**Literature:**

15. SPC Efudix crème en Carac cream (VS).
The gene variation increases the risk of severe, potentially fatal toxicity. A reduced conversion of fluorouracil/capecitabine to inactive metabolites means that the normal dose is an overdose.

- Start with 50% of the standard dose or avoid fluorouracil and capecitabine.

After starting treatment, the dose should be adjusted based on toxicity and effectiveness. In a study involving 17 patients with genotype 1/2846T, the average dose after titration was 64% of the standard dose. For 51 patients with genotype 1/1236A, the average dose after titration was 74% of the standard dose. Tegafur is not an alternative, as this is also metabolised by DPD.

Literature:

22. SPC’s Fluorouracil PCH, Xeloda, Efudix crème, Fluorouracil (VS) en Xeloda (VS).
The gene variation increases the risk of severe, potentially fatal toxicity. A reduced conversion of fluorouracil/capecitabine to inactive metabolites means that the normal dose is an overdose.

- Start with 50% of the standard dose or avoid fluorouracil and capecitabine.
  
  Adjustment of the subsequent dose should be guided by toxicity and effectiveness. However, in one study involving 17 patients with gene activity 1, the average dose after titration was 57% of the standard dose.
  
  Tegafur is not an alternative, as this is also metabolised by DPD.

Literature:

24. Jatoi A et al. Paclitaxel, carboplatin, 5-fluorouracil, and radiation for locally advanced esophageal cancer: phase II results of
36. SPC’s Fluourouracil PCH, Xeloda, Efudix crème, Fluorouracil (VS) en Xeloda (VS).

Date 13-05-2019

DPD FENO: fluorouracil/capecitabine

The gene variation increases the risk of severe, potentially fatal toxicity. A reduced conversion of fluorouracil/capecitabine to inactive metabolites means that the normal dose is an overdose.

It is not possible to recommend a dose adjustment for this patient based on the genotype only.

- determine the residual DPD activity in mononuclear cells from peripheral blood and adjust the initial dose based on phenotype and genotype, or avoid fluorouracil and capecitabine.

Tegafur is not an alternative, as this is also metabolised by DPD.

Literature:

The gene variation increases the risk of severe, potentially fatal toxicity. A reduced conversion of fluorouracil/capecitabine to inactive metabolites means that the standard dose is a more than 100-fold overdose.

- Avoid fluorouracil and capecitabine
  Tegafur is not an alternative, as this is also metabolised by DPD.
- If it is not possible to avoid fluorouracil and capecitabine: determine the residual DPD activity in mononuclear cells from peripheral blood and adjust the initial dose accordingly.
  A patient with 0.5% of the normal DPD activity tolerated 0.8% of the standard dose (150 mg capecitabine every 5 days). A patient with undetectable DPD activity tolerated 0.43% of the standard dose (150 mg capecitabine every 5 days with every third dose skipped)

Literature:

16. SPC’s Fluorouracil PCH, Xeloda, Efudix crème, Fluorouracil (VS), Xeloda (VS) en Carac cream (VS).
CYP2D6 IM: fluoxetine

NO action is needed for this gene-drug interaction.

The ratio of fluoxetine/norfluoxetine increases as a result of the reduced activity of CYP2D6. However, this does not affect the sum of the plasma concentrations of the active substances (fluoxetine and norfluoxetine). There is no effect on adverse events or response.

Literature:

CYP2D6 PM: fluoxetine

NO action is needed for this gene-drug interaction.

The ratio of fluoxetine/norfluoxetine increases as a result of the reduced activity of CYP2D6. However, this does not affect the sum of the plasma concentrations of the active substances (fluoxetine and norfluoxetine). There is insufficient evidence to support an effect on adverse events or response.

Literature:
5. Roberts RL et al. No evidence of increased adverse drug reactions in cytochrome P450 CYP2D6 poor metabolizers treated with fluoxetine or nortriptyline. Hum Psychopharmacol 2004;19:17-23.
7. SPC Prozac, USA, 3-01-09.

CYP2D6 UM: fluoxetine

NO action is needed for this gene-drug interaction.

The ratio of fluoxetine/norfluoxetine decreases as a result of the increased activity of CYP2D6. However, this does not affect the sum of the plasma concentrations of the active substances (fluoxetine and norfluoxetine). There is no effect on adverse events or response.
Literature:


Date 14-05-2018

**CYP2D6 IM: flupentixol**

This is NOT a gene-drug interaction.

No studies have been published in which the kinetics and the effects of flupentixol were studied for this phenotype.

---

Date 14-12-2005

**CYP2D6 PM: flupentixol**

This is NOT a gene-drug interaction.

No studies have been published in which the kinetics and the effects of flupentixol were studied for this phenotype.

---

Date 14-12-2005

**CYP2D6 UM: flupentixol**

This is NOT a gene-drug interaction.

No studies have been published in which the kinetics and the effects of flupentixol were studied for this phenotype.
SLCO1B1 521CC: fluvastatine

This is NOT a gene-drug interaction.

Literature:


SLCO1B1 521TC: fluvastatine

This is NOT a gene-drug interaction.

Literature:


CYP2C19 IM: fluvoxamine

This is NOT a gene-drug interaction.

Literature:

This is NOT a gene-drug interaction.

**Literature:**


This is NOT a gene-drug interaction.

**Literature:**


NO action is needed for this gene-drug interaction.

The plasma concentration of fluvoxamine can increase as a result of the reduced activity of CYP2D6. However, there is insufficient scientific substantiation of an increase in the risk of side effects.

**Literature:**


Date 14-05-2018

**CYP2D6 PM: fluvoxamine**

NO action is needed for this gene-drug interaction.

The plasma concentration of fluvoxamine can increase as a result of the reduced activity of CYP2D6. However, there is no evidence to substantiate an increase in the risk of adverse events.

**Literature:**

1. Christensen M et al. Low daily 10-mg and 20-mg doses of fluvoxamine inhibit the metabolism of both caffeine (cytochrome P4501A2) and omeprazole (cytochrome P4502C19). Clin Pharmacol Ther 2002;71:141-52.
4. SPC’s Fevarin en Luvox (VS).

Date 14-05-2018

**CYP2D6 UM: fluvoxamine**

NO action is needed for this gene-drug interaction.

The plasma concentration of fluvoxamine can decrease as a result of the increased activity of CYP2D6. However, there is no scientific substantiation of a reduced effectiveness.

**Literature:**


Date 14-05-2018

**CYP2D6 IM: gefitinib**

NO action is needed for this gene-drug interaction.

Side effects can occur more frequently, as the gene variation increases the gefitinib plasma concentration. However, the side effects are reversible and manageable, to an extent that adjustment of the therapy in advance is not necessary.
Literature:


Date 19-11-2018

**CYP2D6 PM: gefitinib**

NO action is needed for this gene-drug interaction.

The gefitinib plasma concentration may increase due to reduced CYP2D6 activity. However, there is no evidence to suggest that side effects increase to an extent that adjustment of therapy is needed.

Literature:

3. SPC Iressa.

Date 19-11-2018

**CYP2D6 UM: gefitinib**

NO action is needed for this gene-drug interaction.

The gene variation may lead to a decrease in the gefitinib plasma concentration. In practice, an alternative is only chosen if non-response to gefitinib has been proved. Moreover, dose adjustments guided by the gefitinib plasma concentration are rarely performed in clinical practice as the analytical method is not available in most hospitals.

Literature:

3. SPC Iressa.
CYP2C9 IM: glibenclamide

NO action is required for this gene-drug interaction.

The only relevant clinical consequence that was found is an increased effectiveness of glibenclamide without an increase in the frequency and severity of hypoglycaemia.

Literature:


Date 20-11-2017

CYP2C9 PM: glibenclamide

NO action is required for this gene-drug interaction.

No relevant clinical consequences have been found for the genetic variation.

Literature:


Date 20-11-2017

CYP2C9*1/*2: glibenclamide

NO action is required for this gene-drug interaction.

The only relevant clinical consequence that was found is an increased effectiveness of glibenclamide without an increase in frequency and severity of hypoglycaemia for a group of 1 *1/*2 and 15 *1/*3.

Literature:


CYP2C9*1/*3: glibenclamide

NO action is required for this gene-drug interaction.

The only relevant clinical consequence is an increased effectiveness of glibenclamide without an increase in frequency and severity of hypoglycaemia.

Literature:


CYP2C9*2/*2: glibenclamide

NO action is required for this gene-drug interaction.

No significant clinical consequences have been found for the genetic variation.

Literature:


CYP2C9*2/*3: glibenclamide

NO action is required for this gene-drug interaction.

No significant kinetic or clinical consequences have been found for this genetic variation.
Literature:


Date 20-11-2017

CYP2C9*3/*3: glibenclamide

NO action is required for this gene-drug interaction.

No relevant clinical consequences have been found for this genetic variation.

Literature:


Date 20-11-2017

CYP2C9 IM: gliclazide

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of gliclazide without significantly increasing the risk of hypoglycaemia.

Literature:


Date 20-11-2017

CYP2C9 PM: gliclazide

NO action is required for this gene-drug interaction.
The genetic variation increases the effectiveness of gliclazide without significantly increasing the risk of hypoglycaemia.

Literature:


Date 20-11-2017

CYP2C9*1/*2: gliclazide

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of gliclazide.

Literature:


Date 20-11-2017

CYP2C9*1/*3: gliclazide

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of gliclazide without significantly increasing the risk of hypoglycaemia.

Literature:

CYP2C9*2/*2: gliclazide 1886

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of gliclazide.

Literature:


CYP2C9*2/*3: gliclazide 1887

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of gliclazide.

Literature:


CYP2C9*3/*3: gliclazide 1888

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of gliclazide without significantly increasing the risk of hypoglycaemia.

Literature:


Date 20-11-2017

CYP2C9 IM: glimepiride

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of glimepiride.

Literature:


Date 20-11-2017

CYP2C9 PM: glimepiride

NO action is required for this gene-drug interaction.

Although the genetic variation increases the risk of hypoglycaemia, this risk remains low. This also means that the genetic variation increases the effectiveness. A lack of effectiveness is a much more common problem with sulphonyl urea derivatives than the occurrence of hypoglycaemia.

Literature:

CYP2C9*1/*2: glimepiride

NO action is required for this gene-drug interaction.

No significant kinetic or clinical consequences have been found for the genetic variation.

Literature:


Date 20-11-2017

CYP2C9*1/*3: glimepiride

NO action is required for this gene-drug interaction.

The genetic variation increases the effectiveness of glimepiride.

Literature:

CYP2C9*2/*2: glimepiride

NO action is required for this gene-drug interaction.

No significant clinical effects were observed for this genetic variation.

Literature:


CYP2C9*2/*3: glimepiride

NO action is required for this gene-drug interaction.

Although the genetic variation increases the risk of hypoglycaemia, this risk remains low. This also means that the genetic variation increases the effectiveness. A lack of effectiveness is a much more common problem with sulphonyl urea derivatives than the occurrence of hypoglycaemia.

Literature:


CYP2C9*3/*3: glimepiride

NO action is required for this gene-drug interaction.

Although the genetic variation increases the risk of hypoglycaemia, this risk remains low. This also means that the genetic variation increases the effectiveness. A lack of effectiveness is a much more common problem with sulphonyl urea derivatives than the occurrence of hypoglycaemia.

Literature:

CYP2D6 IM: haloperidol

NO action is required for this gene-drug interaction.

Literature:

8. LLerena A et al. Haloperidol disposition is dependent on the debrisoquine hydroxylation phenotype: increased plasma levels of the reduced metabolite in poor metabolizers. Ther Drug Monit 1992;14:261-4.

Date 22-03-2006

CYP2D6 PM: haloperidol

The genetic polymorphism leads to decreased metabolic capacity of CYP2D6, which may cause increased plasma concentrations of haloperidol and the active metabolite.

Recommendation:

1. Advise the prescriber to:
   1. decrease the initial dose to 50% of the standard initial dose and adjust the dose according to the effect,
   2. or prescribe an alternative.
   Anti-psychotics that are not metabolised via CYP2D6 - or to a much lesser extent - include, for example, flupentixol, fluphenazine, quetiapine, olanzapine or clozapine.

Literature:

5. Yasui-Furukori N et al. Effect of the CYP2D6 genotype on prolactin concentration in schizophrenic patients treated with haloperidol. Schizophr Res 2001 1;52:139-42.
7. LLerena A et al. Haloperidol disposition is dependent on the debrisoquine hydroxylation phenotype: increased plasma levels of the

Date 22-03-2006

CYP2D6 UM: haloperidol

The genetic polymorphism leads to increased metabolic capacity of CYP2D6, which may cause decreased plasma concentrations of haloperidol and the active metabolite reduced haloperidol.

Recommendation:
It is not possible to offer substantiated advice for dose adjustment due to the limited amount of available literature.

1. Advise the prescriber to:
   1. be alert to possible reduced plasma concentrations of haloperidol and reduced haloperidol and increase the dose based on results of therapeutic drug monitoring,
   2. or prescribe an alternative according to the current guidelines.

   Anti-psychotics that are not metabolised via CYP2D6 - or to a much lesser extent - include, for example, flupentixol, fluphenazine, quetiapine, olanzapine or clozapine.

Literature:

Date 22-03-2006

CYP2C19 IM: imipramine

NO action is required for this gene-drug interaction.

The genetic variation increases imipramine plasma concentrations, but not imipramine+desipramine plasma concentrations, which govern effectiveness and side effects.

Literature:
CYP2C19 PM: imipramine

The risk of side effects is increased. The gene variation results in an increase in the plasma concentration of imipramine+desipramine.

- use 70% of the standard dose and monitor the effect and side effects, or the imipramine and desipramine plasma concentrations to determine the maintenance dose.
- or avoid imipramine

Antidepressants that are not or to a lesser extent metabolised by CYP2C19 include, for example, nortriptyline, fluvoxamine and mirtazapine.

Literature:


CYP2C19 UM: imipramine

NO action is required for this gene-drug interaction.

The genetic variation decreases imipramine plasma concentrations, but not imipramine+desipramine plasma concentrations, which govern effectiveness and side effects.

Literature:


CYP2D6 IM: imipramine

The risk of side effects may be increased, because the gene variation leads to increased plasma concentrations of imipramine and desipramine.

- use 70% of the standard dose and monitor the effect and side effects or the plasma concentrations of imipramine and desipramine in order to set the maintenance dose
The therapeutic range is 150-300 ng/mL for the sum of the imipramine and desipramine plasma concentrations. Values exceeding 500 ng/mL are considered toxic.

Literature:


Date 19-11-2018

CYP2D6 PM: imipramine

The risk of side effects may be increased, because the gene variation leads to increased plasma concentrations of imipramine and the active metabolite desipramine.

- use 30% of the standard dose and monitor the effect and side effects or the plasma concentrations of imipramine and desipramine in order to set the maintenance dose
  The therapeutic range is 150-300 ng/mL for the sum of the imipramine and desipramine plasma concentrations. Values exceeding 500 ng/mL are considered toxic.

Literature:

7. SmPC Tofranil-PM (VS).

Date 19-11-2018

CYP2D6 UM: imipramine

The risk of ineffectiveness and cardiotoxic side effects may be increased. The gene variation leads to reduced plasma concentrations of imipramine and the active metabolite desipramine and to increased plasma concentrations of the potentially cardiotoxic hydroxy metabolites.

- use 1.7 times the standard dose and monitor the effect and side effects or the plasma concentrations of imipramine and desipramine in order to set the maintenance dose
- if a dose increase is not wanted due to the potentially cardiotoxic hydroxy metabolites: avoid imipramine.
  Antidepressants that are not metabolised by CYP2D6 - or to a lesser extent - include, for example, citalopram and sertraline.

Date 19-11-2018

UGT1A1 *1/*28: irinotecan

NO action is needed for this gene-drug interaction.

This genetic variation (*1/*28) is more common in Western populations than the wild-type (*1/*1). This means that treatment is largely geared to patients with this genetic variation. Adjustment of the treatment is therefore not useful.

Literature:

23. Massacesi C et al. Uridine diphosphate glucuronosyl transferase 1A1 promoter polymorphism predicts the risk of gastrointestinal
toxicity and fatigue induced by irinotecan-based chemotherapy. Cancer 2006;106:1007-16.


Date 05-03-2018

UGT1A1 *28/*28: irinotecan

Serious, life-threatening adverse events occur more often in patients with this genetic variation. The genetic variation reduces conversion of irinotecan to inactive metabolites.

- Start with 70% of the standard dose
  - If the patient tolerates this initial dose, the dose can be increased, guided by the neutrophil count.

Literature:


41. SPC’s Campto en Camptosar (VS).

Date 05-03-2018

UGT1A1 IM: irinotecan

NO action is needed for this gene-drug interaction.

This genetic variation (IM) is more common in Western populations than the wild-type (*1/*1). This means that treatment is largely geared to patients with this genetic variation. Adjustment of the treatment is therefore not useful.
UGT1A1 PM: irinotecan

1692

Serious, life-threatening adverse events occur more often in patients with this genetic variation. The genetic variation reduces conversion of irinotecan to inactive metabolites.

- Start with 70% of the standard dose
  If the patient tolerates this initial dose, the dose can be increased, guided by the neutrophil count.

**Literature:**


Date 05-03-2018

**CYP2D6 IM: kinidine**  
This is NOT a gene-drug interaction.

Literature:

Date 24-08-2016

**CYP2D6 PM: kinidine**  
This is NOT a gene-drug interaction.

Literature:


Date 24-08-2016

**CYP2D6 UM: kinidine**  
This is NOT a gene-drug interaction.

Literature:

Date 24-08-2016

**CYP2C19 IM: lansoprazol**  
NO action is needed for this gene-drug interaction.

The higher plasma concentration of lansoprazole results in an increase in the therapeutic effectiveness, without an increase in the incidence of side effects.
Literature:

NO action is needed for this gene-drug interaction.

The higher plasma concentration of lansoprazole results in an increase in the therapeutic effectiveness, without an increase in the incidence of side effects.

Literature:

39. SPC Prezal.

Date 05-03-2018

CYP2C19 UM: lansoprazol

The genetic variation may reduce lansoprazole plasma concentrations and therefore lansoprazole effectiveness.

Recommendation:

- For Helicobacter pylori ERADICATION THERAPY:
  1. Use a 4-fold higher dose
  2. Advise the patient to contact their doctor if symptoms of dyspepsia persist

- OTHER INDICATIONS:
  1. Be alert to reduced effectiveness
  2. If necessary, use a 4-fold higher dose
  3. Advise the patient to report persisting symptoms of dyspepsia

Literature:

1. Liou JM et al. Sequential therapy for 10 days versus triple therapy for 14 days in the eradication of Helicobacter pylori in the
41. SPC Prezal.

Date 05-03-2018

CYP2D6 IM: methylfenidaat
This is NOT a gene-drug interaction.

Literature:
-

Date 24-08-2016

CYP2D6 PM: methylfenidaat
This is NOT a gene-drug interaction.

Literature:

Date 24-08-2016

CYP2D6 UM: methylfenidaat
This is NOT a gene-drug interaction.

Literature:
-

Date 24-08-2016
CYP2D6 IM: metoprolol

The gene variation reduces the conversion of metoprolol to inactive metabolites. However, the clinical consequences are limited mainly to the occurrence of asymptomatic bradycardia.

Recommendation:

- If a GRADUAL REDUCTION in HEART RATE is desired, or in the event of SYMPTOMATIC BRADYCARDIA:
  1. increase the dose in smaller steps and/or prescribe no more than 50% of the standard dose
- OTHER CASES:
  1. no action required

Literature:

5. Goryachkina K et al. CYP2D6 is a major determinant of metoprolol disposition and effects in hospitalized Russian patients treated for acute myocardial infarction. Eur J Clin Pharmacol 2008;64:1163-73.

Date 25-05-2016

CYP2D6 PM: metoprolol

The gene variation reduces the conversion of metoprolol to inactive metabolites. However, the clinical consequences are limited mainly to the occurrence of asymptomatic bradycardia.

Recommendation:

- If a GRADUAL REDUCTION in HEART RATE is desired, or in the event of SYMPTOMATIC BRADYCARDIA:
  1. increase the dose in smaller steps and/or prescribe no more than 25% of the standard dose
- OTHER CASES:
  1. no action required
The gene variation increases the conversion of metoprolol to inactive metabolites. This can increase the dose requirement. However, with a target dose of 200 mg/day, there was no effect on the blood pressure and hardly any effect on the reduction of the heart rate.

**Recommendation:**

1. use the maximum dose for the relevant indication as a target dose

2. if the effectiveness is still insufficient: increase the dose based on effectiveness and side effects to 2.5 times the standard dose or select an alternative

   Possible alternatives include:

   - **HEART FAILURE:** bisoprolol or carvedilol. Bisoprolol: advantage: not metabolised by CYP2D6; disadvantage: elimination depends on the kidney function. Carvedilol: advantage: elimination does not depend on the kidney function; disadvantage: is metabolised (to a lesser extent than metoprolol) by CYP2D6.
   - **OTHER INDICATIONS:** atenolol or bisoprolol. Neither is metabolised by CYP2D6.

**Literature:**

5. Goryachkina K et al. CYP2D6 is a major determinant of metoprolol disposition and effects in hospitalized Russian patients treated for acute myocardial infarction. Eur J Clin Pharmacol 2008;64:1163-73.
2. Goryachkina K et al. CYP2D6 is a major determinant of metoprolol disposition and effects in hospitalized Russian patients treated for acute myocardial infarction. Eur J Clin Pharmacol 2008;64:1163-73.

Date 25-05-2016

**CYP2C19 IM: mirtazapine**

This is NOT a gene-drug interaction.

**Literature:**


Date 10-09-2018

**CYP2C19 PM: mirtazapine**

This is NOT a gene-drug interaction.

**Literature:**


Date 10-09-2018

**CYP2C19 UM: mirtazapine**

This is NOT a gene-drug interaction.

**Literature:**


Date 10-09-2018
CYP2D6 IM: mirtazapine

NO action is required for this gene-drug interaction.

The higher plasma concentration of mirtazapine does not result in an increase in the side effects.

Literature:


Date 27-11-2012

CYP2D6 PM: mirtazapine

NO action is required for this gene-drug interaction.

The higher plasma concentration of mirtazapine does not result - or hardly results - in an increase in the side effects.

Literature:


Date 27-11-2012

CYP2D6 UM: mirtazapine

NO action is required for this gene-drug interaction.

The effect on the plasma concentration of mirtazapine is small. No effect has been demonstrated with regard to effectiveness or side effects.
Literature:


Date 27-11-2012

**CYP2C19 IM: moclobemide**

1991

NO action is needed for this gene-drug interaction.

Although the moclobemide plasma concentration may increase as a result of the decreased CYP2C19 activity, this does not lead to an increased incidence of side effects, in as far as is known.

Literature:

2. SPC Aurorix.

Date 04-03-2019

**CYP2C19 PM: moclobemide**

1992

NO action is needed for this gene-drug interaction.

Although the moclobemide plasma concentration may increase as a result of the decreased CYP2C19 activity, this does not lead to an increased incidence of side effects, in as far as is known.

Literature:

3. SPC Aurorix.

Date 04-03-2019

**CYP2C19 UM: moclobemide**

1993

NO action is needed for this gene-drug interaction.

Although the moclobemide plasma concentration may decrease as a result of increased CYP2C19 activity, this does not lead to increased effectiveness, in as far as is known.
The risk of side effects may be increased, because the gene variation leads to an increased plasma concentration of nortriptyline.

- use 60% of the standard dose and monitor the effect and side effects or the plasma concentration of nortriptyline in order to set the maintenance dose
  The therapeutic range of nortriptyline is 50-150 ng/mL. Values exceeding 250 ng/mL are considered toxic.

Literature:


The risk of side effects may be increased, because the gene variation leads to an increased plasma concentration of nortriptyline.

- use 40% of the standard dose and monitor the effect and side effects or the plasma concentration of nortriptyline in order to set the maintenance dose
  The therapeutic range of nortriptyline is 50-150 ng/mL. Values exceeding 250 ng/mL are considered toxic.

Literature:

3. Hodgson K et al. Genetic differences in cytochrome P450 enzymes and antidepressant treatment response. J Psychopharmacol
The risk of ineffectiveness and cardiotoxic effects may be increased. The gene variation leads to a decrease in the plasma concentration of nortriptyline and an increase in the plasma concentration of the cardiotoxic metabolite Z-10-hydroxy nortriptyline.

- Use 1.7 times the standard dose and monitor the effect and side effects or the plasma concentration of nortriptyline and be alert to an increase in the plasma concentration of the cardiotoxic metabolite Z-10-hydroxy nortriptyline.

- Plasma concentrations of Z-hydroxy nortriptyline exceeding 40 ng/mL are considered toxic.

- If a dose increase is not wanted due to the cardiotoxic hydroxy metabolite: avoid nortriptyline.

Antidepressants that are not metabolised via CYP2D6 - or to a lesser extent - include, for example, citalopram and sertraline.

Literature:


This is NOT a gene-drug interaction.

Literature:

**CYP2D6 PM: olanzapine**

This is NOT a gene-drug interaction.

Literature:


Date 22-03-2006

**CYP2D6 UM: olanzapine**

This is NOT a gene-drug interaction.

No studies have been published in which the pharmacokinetics and effects of the use of olanzapine on this phenotype were studied. Studies with PM and IM found no significant association between the genotype and clinical effects (clinical improvements, non-response and extrapyramidal side effects and changes in insulin levels).

Literature:

- 

Date 22-03-2006

**CYP2C19 IM: omeprazol**

NO action is required for this gene-drug interaction.

The higher plasma concentration of omeprazole results in an increase in the therapeutic effectiveness, without an increase in the side effects.

Literature:

8. Ohkusa T et al. Effect of CYP2C19 polymorphism on the safety and efficacy of omeprazole in Japanese patients with recurrent...
29. SmPC Prilosec (VS).

Date 05-03-2018

CYP2C19 PM: omeprazol

NO action is required for this gene-drug interaction.

The higher plasma concentration of omeprazole results in an increase in the therapeutic effectiveness, without an increase in the side effects.

Literature:
5. Saitoh T et al. Influences of CYP2C19 polymorphism on recurrence of reflux esophagitis during proton pump inhibitor
28. SmPC’s Losec en Prilosec (VS).

Date 05-03-2018

CYP2C19 UM: omeprazol

The genetic variation may lead to a reduced omeprazole plasma concentration and therefore reduced effectiveness.

Recommendation:

- For Helicobacter pylori ERADICATION THERAPY:
  1. use a 3-fold higher dose
  2. advise the patient to contact their doctor if symptoms of dyspepsia persist
- OTHER INDICATIONS:
  1. be alert to reduced effectiveness
  2. if necessary, use a 3-fold higher dose
  3. advise the patient to report persisting symptoms of dyspepsia
Literature:

CYP2D6 IM: oxycodon

NO action is required for this gene-drug interaction.

The reduced conversion of oxycodone to the more active metabolite oxymorphone does not result in reduced analgesia for patients.

Literature:


CYP2D6 PM: oxycodon

NO action is required for this gene-drug interaction.

The reduced conversion of oxycodone to the more active metabolite oxymorphone does not result in reduced analgesia in patients.

Literature:

CYP2D6 UM: oxycodon

NO action is required for this gene-drug interaction.

The increased conversion of oxycodone to the more active metabolite oxymorphone does not result in an increase in side effects in patients.

Literature:


CYP2C19 IM: pantoprazol

NO action is required for this gene-drug interaction.

The higher plasma concentration of pantoprazole results in an increase in the therapeutic effectiveness, without an increase in the side effects.

Literature:


Date 05-03-2018

CYP2C19 PM: pantoprazol 1848

NO action is required for this gene-drug interaction.

The higher plasma concentration of pantoprazole results in an increase in the therapeutic effectiveness, without an increase in the side effects.

Literature:

17. SPC’s Pantozol en Protonix I.V. (VS).
The genetic variation may lead to reduced pantoprazole plasma concentrations and therefore reduced pantoprazole effectiveness.

**Recommendation:**

- **For Helicobacter pylori ERADICATION THERAPY:**
  1. use a 5-fold higher dose
  2. advise the patient to contact their doctor if symptoms of dyspepsia persist

- **OTHER INDICATIONS:**
  1. be alert to reduced effectiveness
  2. if necessary, use a 5-fold higher dose
  3. advise the patient to report persisting symptoms of dyspepsia

**Literature:**

20. SPC’s Pantozol en Protonix I.V. (VS).
The plasma concentration of paroxetine can increase as a result of the reduced activity of CYP2D6. However, studies did not find any clinical effects.

Literature:

3. Murata Y et al. Severe sleepiness and excess sleep duration induced by paroxetine treatment is a beneficial pharmacological effect, not an adverse reaction. J Affect Disord 2013;150:1209-12.

Date 14-05-2018

CYP2D6 PM: paroxetine

NO action is needed for this gene-drug interaction.

The plasma concentration of paroxetine can increase as a result of the reduced activity of CYP2D6. However, studies did not find any clinical effects.

Literature:

5. Findling RL et al. Multiple dose pharmacokinetics of paroxetine in children and adolescents with major depressive disorder or

Date 14-05-2018

CYP2D6 UM: paroxetine

Efficacy will probably be lacking. The genetic variation increases the conversion of paroxetine.

It is not possible to offer substantiated advice for dose adjustment based on the literature.

- avoid paroxetine

Antidepressants that are not metabolised by CYP2D6, or to a lesser extent, include for example citalopram or sertraline.

Literature:


Date 14-05-2018

CYP2D6 IM: pimozide

The risk of QT-prolongation – and thereby also the risk of torsade de points – is theoretically increased, because the genetic variation results in an increase in the plasma concentration of pimozide. The risk of an excessively high plasma concentration can be negated by following the dose recommendations provided below.

Recommendation:

- use no more than the following doses (80% of the standard maximum dose):
  - adults 16 mg/day
  - children 0.08 mg/kg per day to a maximum of 3 mg/day

Literature:

1. van der Weide K et al. The influence of the CYP3A4*22 polymorphism and CYP2D6 polymorphisms on serum concentrations of aripiprazole, haloperidol, pimozide, and risperidone in psychiatric patients. J Clin Psychopharmacol 2015;35:228-36

Date 19-11-2018

**CYP2D6 PM: pimozide**

The risk of QT-prolongation – and thereby also the risk of torsade de points – is theoretically increased, because the genetic variation results in an increase in the plasma concentration of pimozide. The risk of an excessively high plasma concentration can be negated by following the dose recommendations provided below.

- use no more than the following doses (50% of the standard maximum dose):
  - adults 10 mg/day
  - children 0.05 mg/kg per day to a maximum of 2 mg/day

Literature:

4. Pharmacogenetic changes to the FDA-approved Orap (pimozide) label include adult and pediatric dosing recommendations for CYP2D6 poor metabolizers. FDA-nieuwsbericht 27-09-11.
5. SPC Orap (NL en VS).

Date 19-11-2018

**CYP2D6 UM: pimozide**

NO action is required for this gene-drug interaction.

This gene variation can result in lower pimozide concentrations. However, there is no evidence of reduced effectiveness.

Literature:


Date 19-11-2018

**CYP2C19 IM: prasugrel**

This is NOT a gene-drug interaction.
Literature:

7. SPC Efient (NL en VS).

Date 19-11-2018

CYP2C19 PM: prasugrel

This is NOT a gene-drug interaction.

Literature:

8. SPC Efient (NL en VS).

Date 19-11-2018

CYP2C19 UM: prasugrel

This is NOT a gene-drug interaction.

Literature:

2. SPC Efient (NL en VS).
CYP2D6 IM: propafenon

Genetic variation increases the sum of the plasma concentrations of propafenone and the active metabolite 5-hydroxypropafenone. This may increase the risk of side effects.

Recommendation:

It is not possible to offer adequately substantiated recommendations for dose adjustment based on the literature.

1. Either guide the dose by therapeutic drug monitoring, perform an ECG and be alert to side effects
2. Or choose an alternative
   Antiarrhythmic drugs that are hardly if at all metabolised by CYP2D6 include, for example, sotalol, disopyramide, quinidine and amiodarone.

Literature:


Date 24-08-2016

CYP2D6 PM: propafenon

Genetic variation increases the sum of the plasma concentrations of propafenone and the active metabolite 5-hydroxypropafenone. This increases the risk of side effects.

Recommendation:

1. Reduce the dose to 30% of the standard dose, perform an ECG and monitor plasma concentrations

Literature:

10. Siddoway LA et al. Polymorphism of propafenone metabolism and disposition in man: clinical and pharmacokinetic
CYP2D6 UM: propafenon

Genetic variation decreases the sum of the plasma concentrations of propafenone and the active metabolite 5-hydroxypropafenone. This increases the risk of reduced or no efficacy.

Recommendation:

It is not possible to offer adequately substantiated recommendations for dose adjustment based on the literature.

1. Either monitor plasma concentrations, perform an ECG and be alert to reduced efficacy of the therapy.
2. Or choose an alternative
   Antiarrhythmic drugs that are hardly if at all metabolised by CYP2D6 include, for example, sotalol, disopyramide, quinidine and amiodarone.

Literature:


CYP2D6 IM: quetiapine

This is NOT a gene-drug interaction.

Literature:


CYP2D6 PM: quetiapine

This is NOT a gene-drug interaction.

Literature:
CYP2D6 UM: quetiapine

This is NOT a gene-drug interaction.

Literature:

CYP2C19 IM: rabeprazol

NO action is required for this gene-drug interaction.

The higher plasma concentration of rabeprazole does not result in an increase in side effects.

Literature:

9. Ariizumi K et al. Therapeutic effects of 10 mg/day rabeprazole administration on reflux esophagitis was not influenced by the CYP2C19 polymorphism. J Gastroenterol Hepatol 2006;21:1428-34.
18. Ando T et al. A comparative study on endoscopic ulcer healing of omeprazole versus rabeprazole with respect to CYP2C19
25. SPC Pariet.

Date 05-03-2018

**CYP2C19 PM: rabeprazol**

NO action is required for this gene-drug interaction.

The higher plasma concentration of rabeprazole does not result in an increase in side effects.

Literature:

10. Ariizumi K et al. Therapeutic effects of 10 mg/day rabeprazole administration on reflux esophagitis was not influenced by the CYP2C19 polymorphism. J Gastroenterol Hepatol 2006;21:1428-34.
There is currently insufficient information about this gene variation to recommend any action. Moreover, the fact that there are no differences in effectiveness between PM and EM patients also makes differences in effectiveness between UM and EM patients less likely.

Literature:

10. Ariizumi K et al. Therapeutic effects of 10 mg/day rabeprazole administration on reflux esophagitis was not influenced by the CYP2C19 polymorphism. J Gastroenterol Hepatol 2006;21:1428-34.
28. SPC’s Pariet en Aciphex (VS).

Date 05-03-2018

CYP2D6 IM: risperidon

NO action is needed for this gene-drug interaction.

There is little evidence to support an increase in side effects caused by the genetic variation. The genetic variation may lead to a decrease in the required maintenance dose. However, as the effect on the dose is smaller than that of the normal biological variation, action is not useful.

Literature:

7. de Leon J et al. A study of genetic (CYP2D6 and ABCB1) and environmental (drug inhibitors and inducers) variables that may influence plasma risperidone levels. Pharmacopsychiatry 2007;40:93-102.
The genetic variation can result in both an increase in side effects and a stronger decrease in schizophrenia symptoms. In addition to this, the genetic variation may lead to a decrease in the required maintenance dose. However, as the effect on the dose is smaller than that of the normal biological variation, action is not useful.

**Literature:**

5. de Leon J et al. A study of genetic (CYP2D6 and ABCB1) and environmental (drug inhibitors and inducers) variables that may influence plasma risperidone levels. Pharmacopsychiatry 2007;40:93-102.

**Date 27-05-2015**

**CYP2D6 UM: risperidon**

NO action is needed for this gene-drug interaction.

Genetic variation may lead to an increase in the required maintenance dose. However, as the effect is smaller than that of the normal biological variation, action is not useful.
Literature:

4. de Leon J et al. A study of genetic (CYP2D6 and ABCB1) and environmental (drug inhibitors and inducers) variables that may influence plasma risperidone levels. Pharmacopsychiatry 2007;40:93-102.

Date 27-05-2015

CYP2C19 IM: sertraline 2008

NO action is needed for this gene-drug interaction.

The gene variation has a minor effect on the sertraline plasma concentration. No effect on side effects was found.

Literature:


Date 14-05-2018

CYP2C19 PM: sertraline 2009

The risk of side effects is increased. The gene variation leads to increased plasma concentrations of sertraline

- Do not give doses exceeding 75 mg/day
- Guide the dose by response and side effects and/or sertraline plasma concentration.

Literature:

Date 14-05-2018

CYP2C19 UM: sertraline

NO action is needed for this gene-drug interaction.

The gene variation has a negligible effect on the plasma concentration of sertraline. Moreover, no significant effect on response and side effects has been found.

Literature:


Date 14-05-2018

CYP2D6 IM: sertraline

This is NOT a gene-drug interaction.

Literature:


Date 14-05-2018

CYP2D6 PM: sertraline

This is NOT a gene-drug interaction.
Literature:


Date 14-05-2018

CYP2D6 UM: sertraline

This is NOT a gene-drug interaction.

Literature:


Date 14-05-2018

SLCO1B1 521CC: simvastatin

The genetic polymorphism leads to reduced simvastatin transport to the liver. This increases simvastatin plasma concentrations and therefore the risk of myopathy.

Recommendation:

1. Choose an alternative
   - Consider any additional risk factors for statin-induced myopathy.
   - Rosuvastatin and pravastatin are influenced to a lesser extent by SLCO1B1 polymorphisms. They are also not influenced by CYP3A4 inhibitors such as amiodarone, verapamil and diltiazem.
   - Fluvastatin is not influenced by SLCO1B1 polymorphisms or CYP3A4 inhibitors.

Literature:

1. Hu M et al. Intronic variants in SLCO1B1 related to statin-induced myopathy are associated with the low-density lipoprotein cholesterol response to statins in Chinese patients with hyperlipidaemia. Pharmacogenet Genomics 2012 Jun 1 [Epub ahead of print].
8. Pasanen MK et al. SLCO1B1 polymorphism markedly affects the pharmacokinetics of simvastatin acid. Pharmacogenet Genomics
SLCO1B1 521TC: simvastatin

The genetic polymorphism may lead to reduced simvastatin transport to the liver. This may increase simvastatin plasma concentrations and therefore the risk of myopathy.

Recommendation:

1. Choose an alternative
   Consider any additional risk factors for statin-induced myopathy.
   Rosuvastatin and pravastatin are influenced to a lesser extent by SLCO1B1 polymorphisms. They are also not influenced by CYP3A4 inhibitors such as amiodarone, verapamil and diltiazem.
   Fluvastatin is not influenced by SLCO1B1 polymorphisms or CYP3A4 inhibitors.

2. If an alternative is not an option:
   1. Avoid simvastatin doses exceeding 40 mg/day
   2. Advise the patient to contact their doctor in the event of muscle symptoms.

Literature:

1. Hu M et al. Intronic variants in SLCO1B1 related to statin-induced myopathy are associated with the low-density lipoprotein cholesterol response to statins in Chinese patients with hyperlipidaemia. Pharmacogenet Genomics 2012 Jun 1 [Epub ahead of print].

CYP2D6 IM: sotalol

This is NOT a gene-drug interaction.

Literature:

-
CYP2D6 PM: sotalol

This is NOT a gene-drug interaction.

Literature:

Date 24-08-2016

CYP2D6 UM: sotalol

This is NOT a gene-drug interaction.

Literature:

Date 24-08-2016

CYP3A5 heterozygote expressor: tacrolimus

Genetic variation results in an increased conversion of tacrolimus to inactive metabolites and as a result a higher dose is required. Adjustment of the initial dose results in an increased chance of reaching a tacrolimus concentration within the target range before the start of therapeutic drug monitoring on day three. However, there is no direct evidence that this results in improved clinical results.

Recommendation:

- Indications OTHER than liver transplantation:
  1. Start with 1.75 times of the standard initial dose that would yield the desired result in non-expressors
     Adjustment of the dose should then be based on therapeutic drug monitoring.
     NOTE: The initial dose that yields the desired result in non-expressors can be lower than the normal initial dose. In the example provided below, this dose was 75 % of the standard initial dose. A 1.75 time dose increase corresponds in this case to a 1.3 time dose increase of the standard initial dose.

     For example: After three days, Thervet et al. found a median trough concentration for tacrolimus of 12.3 ng/mL at an initial dose of 0.15 mg/kg twice daily for heterozygous kidney transplant patients. Their target value was 10 - 15 ng/mL. This is lower than the target value that is used in the Netherlands in the first two - four weeks after kidney transplantation (15 - 20 ng/mL).
     For the reference group of non-expressors, a median trough concentration of 16.6 ng/mL and 12.0 ng/mL was achieved at a dosage of 0.1 mg/kg twice daily and 0.075 mg/kg twice daily respectively. In this hospital, the first dose is administered before the CYP3A5 genotype is known. The second dose is reduced according to the genotype.

- LIVER transplantation:
  In addition to the patient’s genotype, the metabolism of tacrolimus is also determined by the genotype of the transplanted liver.
  - LIVER is also of the genotype HETEROZYGOUS EXPRESSOR:
    1. Start with 1.75 times the standard initial dose
    Adjustment of the dose should then be based on therapeutic drug monitoring.
  - LIVER has a DIFFERENT genotype:
    There is insufficient evidence in the literature to support a dose recommendation.

Literature:
Recommendation:

start of therapeutic drug monitoring on day three. However, there is no direct evidence that this results in improved clinical results.

Adjustment of the initial dose results in an increased chance of reaching a tacrolimus concentration within the target range before the
Genetic variation results in an increased conversion of tacrolimus to inactive metabolites and as a result a higher dose is required.

Indications OTHER than liver transplantation:

- Hesselink DA et al. Genetic polymorphisms of the CYP3A4, CYP3A5, and MDR-1 genes and pharmacokinetics of the calcineurin
- Macphee IA et al. Tacrolimus pharmacogenetics: the CYP3A5*1 allele predicts low dose-normalized tacrolimus blood
- Hesselink DA et al. Genetic polymorphisms of the CYP3A4, CYP3A5, and MDR-1 genes and pharmacokinetics of the calcineurin

Date 09-11-2015

CYP3A5 homozygote expressor: tacrolimus

Genetic variation results in an increased conversion of tacrolimus to inactive metabolites and as a result a higher dose is required. Adjustment of the initial dose results in an increased chance of reaching a tacrolimus concentration within the target range before the start of therapeutic drug monitoring on day three. However, there is no direct evidence that this results in improved clinical results.

Recommendation:

- Indications OTHER than liver transplantation:

  1. Start with 2.5 times the standard initial dose that would yield the desired result in non-expressors
     Adjustment of the dose should then be based on therapeutic drug monitoring.
     NOTE: The initial dose that yields the desired result in non-expressors can be lower than the standard initial dose. In the example provided below, this dose was 75% of the standard initial dose. A 2.5 time dose increase corresponds in this case to a 2 time dose increase of the standard initial dose.

     For example: After three days, Thervet et al. found a median trough concentration for tacrolimus of 14.0 ng/mL at an initial dose of 0.15 mg/kg twice daily for four kidney transplant patients, who were homozygous expressors. This was 5.6 ng/mL (n = 6) for an initial dose of 0.1 mg/kg twice daily. Their target value was 10 - 15 ng/mL. This is lower than the target value that is used in the Netherlands in the first two - four weeks after kidney transplantation (15 - 20 ng/mL).
     For the reference group of non-expressors, a median trough concentration of 16.6 ng/mL and 12.0 ng/mL was achieved at a
dosage of 0.1 mg/kg twice daily and 0.075 mg/kg twice daily respectively. In this hospital, the first dose is administered before the CYP3A5 genotype is known. The second dose is reduced according to the genotype.

- LIVER transplantation:
  In addition to the patient’s genotype, the metabolism of tacrolimus is also determined by the genotype of the transplanted liver.
  - LIVER is also of the genotype HOMOZYGOUS EXPRESSOR:
    1. Start with 2.5 times the standard initial dose Adjustment of the dose should then be based on therapeutic drug monitoring.
  - LIVER has a DIFFERENT genotype:
    There is insufficient evidence in the literature to support a dose recommendation.

Literature:


Date 09-11-2015

CYP2D6 IM: tamoxifen

This gene variation reduces the conversion of tamoxifen to the active metabolite endoxifen. This can result in reduced effectiveness.
Recommendation:

1. select an alternative or measure the endoxifen concentration and increase the dose if necessary by a factor of 1.5-2
2. if TAMOXIFEN is selected: avoid co-medication with CYP2D6 inhibitors such as paroxetine and fluoxetine

Literature:

29. Borges S et al. Quantitative effect of CYP2D6 genotype and inhibitors on tamoxifen metabolism: implication for optimization of


Date 09-11-2015

CYP2D6 PM: tamoxifen

This gene variation reduces the conversion of tamoxifen to the active metabolite endoxifen. This can result in reduced effectiveness.

Recommendation:

1. select an alternative or increase the dose to 40 mg/day and monitor the endoxifen concentration

Studies have demonstrated that PM can achieve an adequate endoxifen concentration when the dose is increased to 40-60 mg/day. Aromatase inhibitors are a possible alternative for post-menopausal women.

Literature:

32. SPC Tamoxifen PCH.

Date 09-11-2015

CYP2D6 UM: tamoxifen

NO action is needed for this gene-drug interaction.

As a result of the genetic variation, the plasma concentration of the active metabolites 4-hydroxytamoxifen and endoxifen can increase. However, there is no evidence that this results in an increase in the side effects.

Literature:


Date 09-11-2015

DPD AS 0: tegafur

The gene variation increases the risk of severe, possibly fatal toxicity. A reduced conversion of tegafur to inactive metabolites means that the normal dose is an overdose.

- avoid tegafur
  Fluorouracil and capecitabine are not suitable alternatives, as these are also metabolised by DPD.
  If it is not possible to avoid tegafur: start with a very low dose and adjust the initial dose based on toxicity and efficacy. A substantiated recommendation for dose reduction cannot be made based on the literature. The recommendation for fluorouracil and capecitabine is to determine the residual DPD activity in mononuclear cells from peripheral blood and to adjust the initial dose accordingly. A patient with 0.5% of the normal DPD activity tolerated 0.8% of the standard capecitabine dose (150 mg every 5 days). A patient with undetectable DPD activity tolerated 0.43% of the standard capecitabine dose (150 mg every 5 days with every third dose skipped).
Literature:

2. SPC Teysuno.

Date 13-05-2019

**DPD AS 1,5: tegafur**

The gene variation increases the risk of severe, possibly fatal toxicity. A reduced conversion of tegafur into inactive metabolites means that the normal dose is an overdose.

- Avoid tegafur or start with a low dose and adjust the initial dose based on toxicity and efficacy
  Fluorouracil and capecitabine are not alternatives, as these are also metabolised by DPD.
  It is not possible to offer substantiated advice for dose reduction based on the literature.
  For fluorouracil and capecitabine, starting with 50 % of the standard dose is recommended and the dose should then be adjusted based on toxicity and effectiveness.
  In one study, the average dose of fluorouracil/capecitabine after titration was 64% of the standard dose for 17 patients with genotype *1/2846T and 74% of the standard dose for 51 patients with genotype *1/1236A.

---

**DPD AS 1: tegafur**

The gene variation increases the risk of severe, possibly fatal toxicity. A reduced conversion of tegafur into inactive metabolites means that the normal dose is an overdose.

- Avoid tegafur or start with a low dose and adjust the initial dose based on toxicity and efficacy
  Fluorouracil and capecitabine are not alternatives, as these are also metabolised by DPD.
  It is not possible to offer substantiated advice for dose reduction based on the literature.
  For fluorouracil and capecitabine, starting with 50 % of the standard dose is recommended.

---

Literature:

3. SPC Teysuno.

Date 13-05-2019
**DPD FENO: tegafur**

The gene variation increases the risk of severe, possibly fatal toxicity. A reduced conversion of tegafur to inactive metabolites means that the normal dose is an overdose.

- Avoid tegafur or start with a low dose and adjust the initial dose based on toxicity and efficacy.
- Fluorouracil and capecitabine are not alternatives, as these are also metabolised by DPD.
- It is not possible to offer substantiated advice for dose reduction based on the literature.
- For fluorouracil and capecitabine, it is recommended to determine the residual DPD activity in mononuclear cells from peripheral blood and adjust the initial dose based on phenotype and genotype.

**Literature:**

3. SPC Teysuno.

---

**CYP2C19 IM: ticagrelor**

This is NOT a gene-drug interaction.

**Literature:**

5. SPC’s Brilique (NL) en Brilinta (VS).

---

**CYP2C19 PM: ticagrelor**

This is NOT a gene-drug interaction.

**Literature:**

8. SPC’s Brilique (NL) en Brilinta (VS).

Date 19-11-2018

CYP2C19 UM: ticagrelor

This is NOT a gene-drug interaction.

Literature:


Date 19-11-2018

NUDT15 IM: tioguanine

Grade ≥ 2 leukopaenia occurs in an estimated 40% of these patients with standard therapy. The genetic variation increases the concentration of the fully activated metabolite of tioguanine.

- IMMUNOSUPPRESSION:
  - start with 75% of the standard dose
    Adjustment of the initial dose should be performed based on toxicity (monitoring of the blood counts) and efficacy.
    Monitoring should be performed at an increased frequency.
    NOTE: The percentage of 75% is based on the analogy with TPMT, for which the gene variants have a comparable effect on toxicity to those of NUDT15.
    NOTE: Dose adjustment based on the total of 6-TGN metabolites is not possible for these patients, as they develop toxicity within the therapeutic range that applies for patients without gene variants.

- LEUKAEMIA:
  - start with 75% of the standard tioguanine dose or start with the standard dose and reduce to 75% if side effects necessitate a dose reduction
    It is not known whether dose reduction in advance results in the same efficacy as dose reduction based on toxicity.
    Adjustment of the initial dose should be performed based on toxicity (monitoring of the blood counts) and efficacy.
    Monitoring should be performed at an increased frequency.
    NOTE: The percentage of 75% is based on the analogy with TPMT, for which the gene variants have a comparable effect on toxicity to those of NUDT15.
    NOTE: Dose adjustment based on the total of 6-TGN metabolites is not possible for these patients, as they develop toxicity within the therapeutic range that applies for patients without gene variants.

Note: more stringent dose reductions are necessary if the patient is also TPMT IM.

Literature:
13. SmPC Lanvis.

Date 04-03-2019

NUDT15 PM: tioguanine

Grade ≥ 2 leukopenia occurs in an estimated 95% of these patients with standard therapy. The genetic variation increases the concentration of the fully activated metabolite of tioguanine.

- avoid tioguanine
- if it is not possible to avoid tioguanine: use 10% of the standard dose and advise patients to seek medical attention when symptoms of myelosuppression (such as severe sore throat in combination with fever, regular nosebleeds and tendency to bruising) occur

Any adjustment of the initial dose should be guided by toxicity (monitoring of blood counts) and efficacy.

Monitoring should be performed at an increased frequency.

NOTE: The percentage of 10% is based on the analogy with azathioprine and mercaptopurine and the analogy with TPMT, for which the gene variants have a comparable effect on toxicity to those of NUDT15. For NUDT15 PM, a percentage of < 20% was calculated for azathioprine and mercaptopurine, but there were insufficient data available to calculate the exact percentage.

NOTE: Dose adjustment based on the total of 6-TGN metabolites is not possible for these patients, as they develop toxicity within the therapeutic range that applies for patients without gene variants.

Literature:

12. SmPC’s Lanvis.

Date 04-03-2019

TPMT IM: tioguanine

Genetic variation reduces conversion of thioguanine to inactive metabolites. This increases the risk of serious adverse events such as myelosuppression.

Recommendation:

- IMMUNOSUPPRESSION:
  - Start with 75% of the standard dose
    Adjustment of the initial dose should be guided by toxicity (monitoring of blood counts) and efficacy.
    The frequency of monitoring should be increased.

- LEUKAEMIA:
  - start with 75% of the standard tioguanine dose, or start with the standard dose and reduce to 75% if side effects necessitate a dose reduction
  It is not known whether dose reduction in advance results in the same efficacy as dose reduction based on toxicity.
  The initial dose should be adjusted based on toxicity (monitoring of the blood counts) and efficacy.
  Monitoring should be performed at an increased frequency.

Note: more stringent dose reductions are necessary if the patient is also NUDT15 IM.

Literature:


Date 04-03-2019

TPMT PM: tioguanine

Genetic variation reduces conversion of thioguanine to inactive metabolites. This increases the risk of serious, life-threatening adverse events such as myelosuppression.

Recommendation:

1. Choose an alternative or start with 6-7% of the standard dose
   Any adjustment of the initial dose should be guided by toxicity (monitoring of blood counts) and effectiveness.
   The frequency of monitoring should be increased.
2. If the dose is decreased: advise patients to seek medical attention when symptoms of myelosuppression (such as severe sore throat in combination with fever, regular nosebleeds and tendency to bruising) develop
Literature:

5. SPC Lanvis.

Date 27-05-2015

CYP2C9 IM: tolbutamide

NO action is required for this gene-drug interaction.

There is insufficient evidence to state that the increased tolbutamide plasma concentration has any clinical consequences.

Literature:


Date 20-11-2017

CYP2C9 PM: tolbutamide

NO action is required for this gene-drug interaction.

No clinical consequences of the increased tolbutamide plasma concentration were observed.

Literature:

2. Vormfelde SV et al. Relative impact of genotype and enzyme induction on the metabolic capacity of CYP2C9 in healthy

Date 20-11-2017

CYP2C9*1/*2: tolbutamide

NO action is required for this gene-drug interaction.

No clinical consequences of the increased tolbutamide plasma concentration were observed.

Literature:

Date 20-11-2017

CYP2C9*1/*3: tolbutamide

NO action is required for this gene-drug interaction.

There is insufficient evidence to state that the increased tolbutamide plasma concentration has any clinical consequences.

Literature:


Date 20-11-2017

**CYP2C9*2/*2: tolbutamide**

NO action is required for this gene-drug interaction.

No clinical consequences of the increased tolbutamide plasma concentration were observed.

**Literature:**


Date 20-11-2017

**CYP2C9*2/*3: tolbutamide**

NO action is required for this gene-drug interaction.

No clinical consequences of the increased tolbutamide plasma concentration were observed.

**Literature:**


Date 20-11-2017

**CYP2C9*3/*3: tolbutamide**

NO action is required for this gene-drug interaction.

No clinical consequences of the increased tolbutamide plasma concentration were observed.
Literature:


Date 20-11-2017

CYP2D6 IM: tramadol

The genetic variation reduces the conversion of tramadol to a metabolite with a higher activity. This can result in reduced analgesia.

Recommendation:
It is not possible to provide a specific recommendation for dose adjustment, because the total analgesic effect changes when the ratio between the mother compound and the active metabolite changes.

1. be alert to a reduced effectiveness
2. in the case of inadequate effectiveness:
   1. try a dose increase
   2. if this does not work: choose an alternative
      Do not select codeine, as this is also metabolised by CYP2D6.
      Morphine is not metabolised by CYP2D6.
      Oxycodone is metabolised by CYP2D6 to a limited extent, but this does not result in differences in analgesia in patients.
3. if no alternative is selected: advise the patient to report inadequate analgesia

Literature:

The genetic variation reduces the conversion of tramadol to a metabolite with a higher activity. This can result in reduced analgesia.

Recommendation:
It is not possible to provide a specific recommendation for dose adjustment, because the total analgesic effect changes when the ratio between the mother compound and the active metabolite changes.

1. be alert to a reduced effectiveness
2. in the case of inadequate effectiveness:
   1. try a dose increase.
   2. if this does not work: choose an alternative
      Do not select codeine, as this is also metabolised by CYP2D6.
      Morphine is not metabolised by CYP2D6.
      Oxycodone is metabolised by CYP2D6 to a limited extent, but this does not result in differences in analgesia in patients.
3. if no alternative is selected: advise the patient to report inadequate analgesia

Literature:
18. SPC Ultram (VS).
As the total analgesic effect changes when the ratio between the mother compound and the active metabolite changes, the effect of a dose reduction cannot be predicted with certainty.

- select an alternative
  Do not choose codeine, as it is contra-indicated for CYP2D6 UM.
  Morphine is not metabolised by CYP2D6.
  Oxycodone is metabolised by CYP2D6 to a limited extent, but this does not result in differences in side effects in patients.

- if an alternative is not possible:
  - use 40% of the standard dose
  - advise the patient to report side effects (such as drowsiness, confusion, constipation, nausea and vomiting, respiratory depression or urine retention).

Literature:

10. SPC Ultram (VS).

There are indications of an increased risk of side effects and a reduced chance of efficacy. The gene variation reduces the conversion of venlafaxine to the active metabolite O-desmethylvenlafaxine, whilst an association between high O-desmethylvenlafaxine/venlafaxine ratios and response without side effects was found.

It is not possible to offer adequately substantiated advice for dose reduction based on the literature.

- avoid venlafaxine
  Antidepressants that are not metabolised by CYP2D6 - or to a lesser extent - include, for example, duloxetine, mirtazapine, citalopram and sertraline.
- if it is not possible to avoid venlafaxine and side effects occur:
  1. reduce the dose
  2. monitor the effect and side effects or check the plasma concentrations of venlafaxine and O-desmethylvenlafaxine
     It is not known whether it is possible to reduce the dose to such an extent that the side effects disappear, while the effectiveness is maintained. 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.

Literature:

2. Taranu A et al. Should a routine genotyping of CYP2D6 and CYP2C19 genetic polymorphisms be recommended to predict...


There are indications of an increased risk of side effects and a reduced chance of efficacy. The gene variation reduces the conversion of venlafaxine to the active metabolite O-desmethylvenlafaxine, whilst an association between high O-desmethylvenlafaxine/venlafaxine ratios and response without side effects was found.

It is not possible to offer adequately substantiated advice for dose reduction based on the literature.

- avoid venlafaxine
  Antidepressants that are not metabolised by CYP2D6 - or to a lesser extent - include, for example, duloxetine, mirtazapine, citalopram and sertraline.

- If it is not possible to avoid venlafaxine and side effects occur:
  1. reduce the dose
  2. monitor the effect and side effects or check the plasma concentrations of venlafaxine and O-desmethylvenlafaxine

It is not known whether it is possible to reduce the dose to such an extent that the side effects disappear, while the effectiveness is maintained. 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. Furthermore, a reduced effectiveness of venlafaxine has been observed in depression patients with this gene variation.

**Literature:**


5. Ng C et al. Pharmacogenetic polymorphisms and response to escitalopram and venlafaxine over 8 weeks in major depression.
It may be difficult to adjust the dose for patients due to altered metabolism between venlafaxine and the active metabolite O-desmethylvenlafaxine. The gene variation increases the conversion of venlafaxine to O-desmethylvenlafaxine and reduces the sum of venlafaxine plus O-desmethylvenlafaxine.

1. be alert to a possible decrease in the sum of the plasma concentrations of venlafaxine and the active metabolite O-desmethylvenlafaxine
2. if necessary, increase the dose to 150% of the standard dose
3. if dose adjustment does not result in efficacy without unacceptable side effects or if dose adjustment based on therapeutic drug monitoring is not possible, then venlafaxine should be avoided

Antidepressants that are not metabolised by CYP2D6 - or to a lesser extent - include, for example, duloxetine, mirtazapine, citalopram and sertraline.

Literature:


The gene variation can reduce the conversion of voriconazole and consequently increase the plasma concentration. This could result in improved efficacy or an increase in the risk of side effects.

Recommendation:

- Monitor the plasma concentration
Literature:

25. SPC Vfend.

Date 01-05-2017

CYP2C19 PM: voriconazol

The gene variation can reduce the conversion of voriconazole and consequently increase the plasma concentration. This could result in improved efficacy or an increase in the risk of side effects. Initially, the risk of side effects is of particular interest.

Recommendation:

- Use 50% of the standard dose and monitor the plasma concentration
Literature:

22. SPC Vfend.

Date 01-05-2017

CYP2C19 UM: voriconazol

The gene variation increases the conversion of voriconazole, which increases the risk of ineffectiveness.

Recommendation:

- Use an initial dose that is 1.5x higher and monitor the plasma concentration

Literature:


Date 01-05-2017

**CYP2C9 IM: warfarine**

This gene variation reduces the conversion of warfarin to inactive metabolites. This can increase the risk of bleeding.

Recommendation:

1. use 65% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm. Algorithms for Caucasian patients usually contain only the *2 and *3 allele. If the activity of the reduced-activity alleles is comparable to the activity of *2 or *3, then the algorithm can be completed as if *1/*2 or *1/*3 is present. See https://www.knmp.nl/producten-en-diensten/gebruiksrecht-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics for Excel files containing calculation modules for oral and equivalent intravenous doses. From day 6 on the standard algorithm without genotype information can be used to calculate the dose.

Modified dose algorithms have been developed for patients of African or (East) Asian heritage.

**Literature:**

9. SPC Coumadin (VS).

Date 24-08-2016
CYP2C9 PM: warfarine

This gene variation reduces the conversion of warfarin to inactive metabolites. This can increase the risk of bleeding.

Recommendation:

1. use 20% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm. Algorithms for Caucasian patients usually contain only the *2 and *3 allele. If the activity of the reduced-activity alleles is comparable to the activity of *2 or *3, then the algorithm can be completed as if *2 or *3 is present. See https://www.knmp.nl/producten-en-diensten/gebruiksrecht-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics for Excel files containing calculation modules for oral and equivalent intravenous doses. From day 6 on the standard algorithm without genotype information can be used to calculate the dose.

Modified dose algorithms have been developed for patients of African or (East) Asian heritage.

Literature:

9. SPC Coumadin (VS).

Date 24-08-2016

CYP2C9*1/*2: warfarine

NO action is required for this gene-drug interaction.

Genetic variation may lead to a decrease in the required maintenance dose. However, there is insufficient evidence that this causes problems when therapy is initiated as usual.

Literature:

CYP2C9*1/*3: warfarine

This gene variation reduces the conversion of warfarin to inactive metabolites. This can increase the risk of bleeding.

Recommendation:
1. use 65% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm, as used in EU-PACT: see https://www.knmp.nl/producten-en-diensten/gebruiksrecht-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics.

From day 6 on the standard algorithm without genotype information can be used to calculate the dose.

Literature:

9. SPC Coumadin (VS).

CYP2C9*2/*2: warfarine

This gene variation reduces the conversion of warfarin to inactive metabolites. This can increase the risk of bleeding.

Recommendation:
1. use 65% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm, as used in EU-PACT: see https://www.knmp.nl/producten-en-diensten/gebruiksrecht-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics.

From day 6 on the standard algorithm without genotype information can be used to calculate the dose.
Literature:

9. SPC Coumadin (VS).

Date 24-08-2016

**CYP2C9*2/*3: warfarine**

This gene variation reduces the conversion of warfarin to inactive metabolites. This can increase the risk of bleeding.

**Recommendation:**

1. use 45% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm, as used in EU-PACT: see [https://www.knmp.nl/producten-en-diensten/gebruiksrecht-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics](https://www.knmp.nl/producten-en-diensten/gebruiksrecht-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics).

From day 6 on the standard algorithm without genotype information can be used to calculate the dose.

Date 24-08-2016

**CYP2C9*3/*3: warfarine**

This gene variation reduces the conversion of warfarin to inactive metabolites. This can increase the risk of bleeding.

Literature:

9. SPC Coumadin (VS).
Recommendation:

1. use 20% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm, as used in EU-PACT: see https://www.knmp.nl/producten-en-diensten/bruksrechtt-g-standaard/medicatiebewaking-g-standaard/background-information-pharmacogenetics.

From day 6 on the standard algorithm without genotype information can be used to calculate the dose.

Literature:

9. SPC Coumadin (VS).

Date 24-08-2016

**VKORC1 -1639 AA: warfarine**

The genetic variation results in increased sensitivity to warfarin. This results in an increase in the risk of excessively severe inhibition of blood clotting (INR > 4) during the first month of the treatment.

Recommendation:

1. use 60% of the standard initial dose

The genotype-specific initial dose and maintenance dose can be calculated using an algorithm, as used in EU-PACT: see https://www.knmp.nl/patientenzorg/medicatiebewaking/farmacogenetica.

From day 6 on the standard algorithm without genotype information can be used to calculate the dose.

Literature:

7. Yang J et al. Influence of CYP2C9 and VKORC1 genotypes on the risk of hemorrhagic complications in warfarin-treated patients:
10. SPC Coumadin (VS).

Date 24-08-2016

**VKORC1 -1639 GA: warfarine**

NO action is required for this gene-drug interaction.

The genetic variation results in a reduction in the required dose and an increase in the risk of excessively severe inhibition of blood clotting during the first month of the treatment. However, the effect is small and GA is also the most common genotype, meaning that the standard treatment will primarily be based on patients with this genotype.

Literature:

7. Jerling M et al. The CYP2D6 genotype predicts the oral clearance of the neuroleptic agents perphenazine and zuclopentixol. Clin

Date 24-08-2016

**CYP2D6 IM: zuclopentixol**

The genetic polymorphism leads to decreased metabolic capacity of CYP2D6, which may cause increased zuclopentixol plasma concentrations.

Recommendation:

1. Advise the prescriber to start with 75% of the standard dose or to choose an alternative according to the current guidelines. Antipsychotics that are not metabolised via CYP2D6 - or to a lesser extent - include, for example, flupentixol, quetiapine, olanzapine and clozapine.

Literature:

3. Jerling M et al. The CYP2D6 genotype predicts the oral clearance of the neuroleptic agents perphenazine and zuclopentixol. Clin
The genetic polymorphism leads to decreased metabolic capacity of CYP2D6, which may cause increased zuclopentixol plasma concentrations.

Recommendation:

1. Advise the prescriber to start with 50% of the standard dose or to choose an alternative according to the current guidelines. Antipsychotics that are not metabolised via CYP2D6 - or to a lesser extent - include, for example, flupentixol, quetiapine, olanzapine and clozapine.

Literature:


The genetic polymorphism leads to increased metabolic capacity of CYP2D6, which may cause decreased zuclopentixol plasma concentrations.

Recommendation:

No data have been published from studies into the pharmacokinetics and effects of zuclopentixol for this phenotype.

1. As a precaution, the prescriber should advised to be alert to a decreased zuclopentixol plasma concentration and - if necessary - the dose should be increased on the basis of the clinical effect, or an alternative should be prescribed according to the current guidelines. Antipsychotics that are not metabolised via CYP2D6 - or to a lesser extent - include, for example, flupentixol, quetiapine, olanzapine and clozapine.

Literature:

-