

Children's Minnesota Pharmacogenomics Implementation

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Pharmacogenomics Program Director

Children's Minnesota

One of the largest freestanding pediatric health systems in the United States



Minneapolis

St Paul



429 Staffed beds
5,230 Employees

Children's Minnesota

- 12 Primary care clinics

Primary care clinic visits

268,273



- 2 Emergency Departments



96,443

Emergency department visits

- 9 Specialty care sites

Specialty clinic visits

93,894

447,731

OUTPATIENT CLINIC VISITS TOTAL

- 6 Rehabilitation sites

Rehabilitation clinic visits

85,564

700

Children's
MINNESOTA

Genomic Medicine Program
Genomics, Pharmacogenomics
and Genetic Counseling

Pharmacogenomics Oversight Committee (POC)

- Membership
 - Pharmacist, Chair
 - Genetics/genomics
 - Hematology/oncology
 - Behavioral health
 - Anesthesiology
 - Pathology
 - Clinical informatics
 - CMIO
 - Administration/strategy
 - Ad hoc – Antimicrobial Stewardship, Pain and Palliative Care, Developmental Pediatrics

Pharmacogenomics Clinic

- Clinic opened 2/10/2017
- Pharmacist and genetic counselor
- Referred by primary care, behavioral health, and developmental pediatrics services
- Appointment types:
 - Pre-test evaluation appointment
 - Prior authorization obtained before PGx testing ordered
 - Results review appointment
- 2 – 3 patients 1 day per week
- 1 – 2 inpatient consults per month

Children's Minnesota EHR Implementation

- PGx result entry
- PGx result display
- Electronic clinical decision support

PGx Result Entry in EHR – Cerner PowerForm

- Results received in PDF format from all PGx labs
 - Requires result entry by hand
- PowerForm Functionality
 - Entry of discrete PGx results
 - Automatically builds interpretive consults
 - Allows for customized interpretive consults
- Standard consult text exists in a table outside of the results page.
 - Allows for updating interpretive consult without updating each result individually.

PGx Result Entry in EHR – Cerner PowerForm

Pharmacogenomics Interp Results - Taggart, Jack Nolan

*Performed on: 02/28/2018 2124 CST By: Gregorik PharmD, David B

Pharmacogenomics CYP2C19 Results

Laboratory: RPRD (Pharmacocan) RPRD (Custom - CNT Panel) GeneSight (Assures) OneOne MCW (DMET) Prometheus Other:

CYP2C19 Genotype

| | | | | | | |
|------------------------------|---|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <input type="radio"/> *1/*1 | <input type="radio"/> *1/*9 | <input type="radio"/> *2/*3 | <input type="radio"/> *2A/*2B | <input type="radio"/> *2B/*2B | <input type="radio"/> *3/*3 | <input type="radio"/> *17/*17 |
| <input type="radio"/> *1/*2 | <input type="radio"/> *1/*15 | <input type="radio"/> *2/*4 | <input type="radio"/> *2A/*3 | <input type="radio"/> *2B/*3 | <input type="radio"/> *3/*4 | <input type="radio"/> *17/*27 |
| <input type="radio"/> *1/*2A | <input type="radio"/> *1/*17 | <input type="radio"/> *2/*6 | <input type="radio"/> *2A/*4 | <input type="radio"/> *2B/*4 | <input type="radio"/> *4/*4 | <input type="radio"/> *27/*27 |
| <input type="radio"/> *1/*2B | <input type="radio"/> *1/*27 | <input type="radio"/> *2/*17 | <input type="radio"/> *2A/*6 | <input type="radio"/> *2B/*6 | <input type="radio"/> *4/*15 | <input type="radio"/> Other: |
| <input type="radio"/> *1/*3 | <input checked="" type="radio"/> *1/*22 | <input type="radio"/> *2/*27 | <input type="radio"/> *2A/*17 | <input type="radio"/> *2B/*17 | <input type="radio"/> *4/*17 | |
| <input type="radio"/> *1/*4 | <input type="radio"/> *2/*2 | <input type="radio"/> *2A/*2A | <input type="radio"/> *2A/*27 | <input type="radio"/> *2B/*27 | <input type="radio"/> *15/*27 | |

CYP2C19 Results Interpretation

Automated Results

Abnormal Flag: Normal Abnormal

Phenotype

| | | |
|--|---|---|
| <input type="radio"/> Ultrarapid Metabolizer | <input type="radio"/> Intermediate Metabolizer | <input type="radio"/> Poor Metabolizer |
| <input type="radio"/> Rapid Metabolizer | <input type="radio"/> Possible Intermediate Metabolizer | <input type="radio"/> Unknown Metabolizer |
| <input type="radio"/> Normal Metabolizer | <input type="radio"/> Possible Poor Metabolizer | |

Diplotype Interpretation

- This result signifies that the patient has two copies of a normal function allele.
- This result signifies that the patient has one copy of a normal function allele and one copy of a no function allele.
- This result signifies that the patient has one copy of a normal function allele and one copy of a possible no function allele.
- This result signifies that the patient has two copies of a no function allele.
- This result signifies that the patient MAY have two copies of a no function allele.
- This result signifies that the patient has two copies of an increased function allele.
- This result signifies that the patient has one copy of a normal function allele and one copy of an increased function allele.
- This result signifies that the patient has one copy of an increased function allele and one copy of a no function allele.
- This result signifies that the patient has one copy of an increased function allele and one copy of a decreased function allele.
- This result signifies that the patient has one copy of a normal function allele and one copy of a decreased function allele.
- This result signifies that the patient has one copy of a decreased function allele and one copy of a no function allele.
- This result signifies that the patient has two copies of a decreased function allele.

Interpretive Result Display

| Phenotype Assignment | Dosing Recommendation |
|---|--|
| <p>Ultrarapid Metabolizer</p> <p>Based on the genotype result this patient is predicted to be an ultrarapid metabolizer of CYP2C19 substrates.</p> | <p>Best Clinical Management: The patient may be at risk for an adverse or poor response to medications that are metabolized by CYP2C19. To avoid an untoward drug response, dose adjustments or alternative therapeutic agents may be necessary for medications metabolized by CYP2C19. Please consult a clinical pharmacist for more information about how CYP2C19 metabolic status influences drug selection and dosing.</p> |
| <p>Rapid Metabolizer</p> <p>Based on the genotype result this patient is predicted to be a rapid metabolizer of CYP2C19 substrates.</p> | <p>Best Clinical Management: The patient may be at risk for an adverse or poor response to medications that are metabolized by CYP2C19. To avoid an untoward drug response, dose adjustments or alternative therapeutic agents may be necessary for medications metabolized by CYP2C19. Please consult a clinical pharmacist for more information about how CYP2C19 metabolic status influences drug selection and dosing.</p> |
| <p>Normal</p> <p>Based on the genotype result this patient is predicted to be a normal</p> | |

Preliminary

PGx Result Entry in EHR – Cerner PowerForm

*Performed on: 02/28/2018 2124 CST By: Gregorik PharmD, David B

Pharmacogenomics CYP2C19 Results

Laboratory RPRD (Pharmacoscan) RPRD (Custom - CNT Panel) GeneSight (Assurex) OneOme MCW (DMET) Prometheus Other

CYP2C19 Genotype

*1/*1 *1/*9 *2/*3 *2A/*2B *2B/*2B *3/*3 *17/*17
 *1/*2 *1/*15 *2/*4 *2A/*3 *2B/*3 *3/*4 *17/*27
 *1/*2A *1/*17 *2/*6 *2A/*4 *2B/*4 *4/*4 *27/*27
 *1/*2B *1/*27 *2/*17 *2A/*6 *2B/*6 *4/*15 Other
 *1/*3 *1/*35 *2/*27 *2A/*17 *2B/*17 *4/*17
 *1/*4 *2/*2 *2A/*2A *2A/*27 *2B/*27 *15/*27

CYP2C19 Results Interpretation

Automated Results

Abnormal Flag Normal Abnormal

Phenotype

Ultrarapid Metabolizer Intermediate Metabolizer Poor Metabolizer
 Rapid Metabolizer Possible Intermediate Metabolizer Unknown Metabolizer
 Normal Metabolizer Possible Poor Metabolizer

Diploype Interpretation

This result signifies that the patient has two copies of a normal function allele.
 This result signifies that the patient has one copy of a normal function allele and one copy of a no function allele.
 This result signifies that the patient has one copy of a normal function allele and one copy of a possible no function allele.
 This result signifies that the patient has two copies of a no function allele.
 This result signifies that the patient MAY have two copies of a no function allele.
 This result signifies that the patient has two copies of an increased function allele.
 This result signifies that the patient has one copy of a normal function allele and one copy of an increased function allele.
 This result signifies that the patient has one copy of an increased function allele and one copy of a no function allele.
 This result signifies that the patient has one copy of an increased function allele and one copy of a decreased function allele.
 This result signifies that the patient has one copy of a normal function allele and one copy of a decreased function allele.
 This result signifies that the patient has one copy of a decreased function allele and one copy of a no function allele.
 This result signifies that the patient has two copies of a decreased function allele.

Result Display **Phenotype Assignment** **Dosing Recommendation**

Ultrarapid Metabolizer Based on the genotype result this patient is predicted to be an ultrarapid metabolizer of CYP2C19 substrates.

Rapid Metabolizer Based on the genotype result this patient is predicted to be a rapid metabolizer of CYP2C19 substrates.

Normal Based on the genotype result this patient is predicted to be a normal metabolizer of CYP2C19 substrates.

Best Clinical Management The patient may be at risk for an adverse or poor response to medications that are metabolized by CYP2C19. To avoid an untoward drug response, dose adjustments or alternative therapeutic agents may be necessary for medications metabolized by CYP2C19. Please consult a clinical pharmacist for more information about how CYP2C19 metabolic status influences drug selection and dosing.

Best Clinical Management The patient may be at risk for an adverse or poor response to medications that are metabolized by CYP2C19. To avoid an untoward drug response, dose adjustments or alternative therapeutic agents may be necessary for medications metabolized by CYP2C19. Please consult a clinical pharmacist for more information about how CYP2C19 metabolic status influences drug selection and dosing.

Preliminary

PGx Result Entry in EHR – Cerner PowerForm

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Metabolizer Based on the genotype result this patient MAY be a poor metabolizer of CYP2C19 substrates. To avoid an untoward drug response, dose adjustments or alternative therapeutic agents may be necessary for medications metabolized by CYP2C19. Please consult a clinical pharmacist for more information about how CYP2C19 metabolic status influences drug selection and dosing.

Poor Metabolizer Based on the genotype result this patient is predicted to be a poor metabolizer of CYP2C19 substrates. Best Clinical Management: The patient is at high risk for an adverse or poor response to medications that are metabolized by CYP2C19. To avoid an untoward drug response, dose adjustments or alternative therapeutic agents may be necessary for medications metabolized by CYP2C19. Please consult a clinical pharmacist for more information about how CYP2C19 metabolic status influences drug selection and dosing.

Unknown Metabolizer The expected phenotype for this patient cannot be determined based upon the CYP2C19 diplotype result. Please consult with a clinical pharmacist for further information, and the possibility of ordering a CYP2C19 phenotype test.

Personalized Results

Diplotype Interpretation Tahoma 9

Phenotype Assignment Tahoma 9

Dosing Recommendation Tahoma 9

Change Due To Tahoma 9

Preliminary

Pharmacogenomic Results Page (Cerner M-page)

Menu

- Pt Info
- Lifetime Clinical Team
- Pt Home Plan of Care
- Problem List
- Past Medical/Family/Social Hx
- Orders **+ Add**
- Future Orders
- Quick Orders
- MAR
- Interv/I&O
- Form Browser
- Allergies **+ Add**
- Notes
- Immunization Hx
- Clinical Summary
- Workflow Summary
- Outside Records
- Growth Chart
- MAR Summary
- Medication List **+ Add**
- MedSurg QV
- NICU QV
- PICU QV
- Patient Schedule
- Flowsheets
- Micro Viewer
- Pharmacogenomics**
- Activities & Interventions
- Visit History
- Immunization Schedule
- MIIC

Pharmacogenomics

These pharmacogenomic results and interpretations are based on CPIC (Clinical Pharmacogenetics Implementation Consortium) guidelines (<https://cpicpax.org/>) and Children's pharmacogenomic experts may differ from laboratory report interpretations.

See Scanned DNA results under Clinical Documents, Lab Documents

- Choose Alternative Medication or Use With Caution**
- Medications May Require Dose Adjustments**

Abnormal Results

- CYP2D6 (*1/*2)3N Phenotype: Ultrarapid Metabolizer
- TPMT *1/*3A, *3B/*3C Phenotype: Intermediate Metabolizer

Normal Results

- CYP2C19 *1/*1 Phenotype: Normal Metabolizer

Relevant Results

- MTHFR rs1801133 G/G Phenotype: Uncertain significance

Additional Pharmacogenomics Resources

<http://intranet.childrensmn.org/references/genetics/>
Cerner message pool: Pharmacogenomics
Contacts: David Gregornik, PharmD, pager 651-629-0198

Measurements

Height: 151.7 cm
BSA: 1.314 m²

Current Medication List

alteplase 2 mg, 2 mL, IV, PRN, PRN: line occlusion
heparin lock 50 Units, 5 mL, IV, PRN, PRN: flush/lock
lidocaine topical 1 application, Topically, PRN, PRN: IV start/access port
sodium chloride 0.9% 1,000 mL See Comment, IV

Home Medication List

mercaptopurine 25 mg, 0.5 TABLET, PO, QDay, for 4 Week(s), 30 TABLET, 3 Refill(s)
dasatinib 80 mg, 1 TABLET, PO, QDay, 30 TABLET, 6 Refill(s)
lidocaine-prilocaine topical 1 application, Topically, PRN, for 2 Days, PRN: other, 30 g, 0 Refill(s)
sulfamethoxazole-trimethoprim 240 mg, 1.5 TABLET, PO, M&Tu, 13.5 TABLET, 11 Refill(s)

P0033 CE154407 February 28, 2018 18:03 CST

Pharmacogenomic Results Page (Cerner M-page)

Pharmacogenomics

These pharmacogenomic results and interpretations are based on CPIC (Clinical Pharmacogenetics Implementation Consortium) guidelines (<https://cpicpx.org/>) and Children's pharmacogenomic experts may differ from laboratory report interpretations.

- ▶ **Choose Alternative Medication or Use With Caution**
- ▶ **Medications May Require Dose Adjustments**
- ▶ **Abnormal Results**
 - ▶ CYP2D6 (*1/*2)3N Phenotype: Ultrarapid Metabolizer
 - ▶ TPMT *1/*3A, *3B/*3C Phenotype: Intermediate Metabolizer
- ▶ **Normal Results**
 - ▶ CYP2C19 *1/*1 Phenotype: Normal Metabolizer

Additional Pharmacogenomics Resources

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Cerner message pool: Pharmacogenomics
Contacts: David Gregornik, PharmD, pager 651-629-0198

Measurements

Height: 149.9 cm
BSA: 1.293 m2

Current Medication List

Home Medication List

albuterol 1 PUFF, Inhalation, Q4H PRN, 1 EACH, PRN: wheezing
cetirizine 10 mg, 1 TABLET, PO, QDay, 0 Refill(s)
cholecalciferol (Vitamin D3) 1,000 Units, 1 TABLET, PO, QDay, for 90 Days, 90 TABLET, 3 Refill(s)
dasatinib 80 mg, 1 TABLET, PO, QDay, 30 TABLET, 0 Refill(s)
mercaptopurine 25 mg, 0.5 TABLET, PO, QDay, for 4 Week(s), 30 TABLET, 3 Refill(s)
fluticasone nasal 0 Refill(s)
lidocaine-prilocaine topical 1 application, Topically, PRN, for 2 Days, PRN: other, 30 g, 0 Refill(s)
sulfamethoxazole-trimethoprim 240 mg, 1.5 TABLET, PO, M&Tu, 13.5 TABLET, 11 Refill(s)
voriconazole 50 mg, 1 TABLET, PO, Q12H, take with 200 mg tab for total of 250 mg BID, 60 TABLET, 0 Refill(s)
voriconazole 200 mg, 1 TABLET, PO, Q12H, for 30 Days, 60 TABLET, 0 Refill(s)

Gene/Drug Interactions highlighted in RED

Interpretive Consult for Individual Results

Menu

- Pt Info
- Lifetime Clinical Team
- Pt Home Plan of Care
- Problem List
- Past Medical/Family/Social Hx
- Orders + Add
- Future Orders
- Quick Orders
- MAR
- View/1&O
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- Clinical Doc
- I & O Sum
- Immunization Hx
- Clinical Summary
- Workflow Summary
- Growth Chart
- MAR Summary
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- MedSurg QV
- NICU QV
- PICU QV
- Patient Schedule
- Results
- Micro Viewer
- Pharmacogenomics**
- Task List
- Visit History
- Immunization Schedule

Pharmacogenomics
Full screen Print 1 minutes ago

Pharmacogenomics

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▶ **Choose Alternative Medication or Use With Caution**

▶ **Medications May Require Dose Adjustments**

Abnormal Results

- ▶ CYP2D6 (*1/*2)3N Phenotype: Ultrarapid Metabolizer
- ▶ TPMT *1/*3A, *3B/*3C Phenotype: Intermediate Metabolizer

Interpretive Result

Diplotype Interpretation: This result signifies that the patient has one copy of a normal function allele and one copy of a no function allele.

Phenotype Assignment: This patient is predicted to be a TPMT intermediate metabolizer. The patient is at risk for myelosuppression with normal doses of drugs in the thiopurine class (6-mercaptopurine, thioguanine or azathioprine), and thus reduced starting doses may be needed. Some experts recommend lower doses of thiopurines in heterozygotes because these patients may be at higher risk of thiopurine-related late secondary cancers.

Dosing Recommendation:

Clinical Trial/Protocol: Follow dosing and management guidelines as outlined in the protocol.

Best Clinical Management: For 6-mercaptopurine and azathioprine, consider starting at 30%-70% of the normal dose. For example, a normal dose of 6-mercaptopurine (e.g. 75 mg/m²/day) should be reduced to 20-50 mg/m²/day. A normal dose of azathioprine (2-3 mg/kg/day) should be reduced to 0.6-2.0 mg/kg/day. For thioguanine reduce the normal dose by 30-50%. Titrate thiopurine doses based on myelosuppression. In the setting of myelosuppression, and depending on other therapy, emphasis should be on reducing thiopurine doses over other agents. Allow 2-4 weeks to reach steady-state after each dosage adjustment. For drug monitoring, consider obtaining an erythrocyte thiopurine metabolite concentrat

Normal Results

- ▶ CYP2C19 *1/*1 Phenotype: Normal Metabolizer

Additional Pharmacogenomics Resources

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Cerner message pool: Pharmacogenomics

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cetirizine 10 mg, 1 TABLET, PO, QDay, 0 Refill(s)

cholecalciferol (Vitamin D3) 1,000 Units, 1 TABLET, PO, QDay, for 90 Days, 90 TABLET, 3 Refill(s)

dasatinib 80 mg, 1 TABLET, PO, OD, 30 TABLET, 0 Refill(s)

mercaptopurine 25 mg, 0.5 TABLET, PO, QDay, for 4 Week(s), 30 TABLET, 3 Refill(s)

fluticasone nasal 0 Refill(s)

lidocaine-prilocaine topical 1 application, Topically, PRN, for 2 Days, PRN: other, 30 g, 0 Refill(s)

sulfamethoxazole-trimethoprim 240 mg, 1.5 TABLET, PO, M&Tu, 13.5 TABLET, 11 Refill(s)

voriconazole 50 mg, 1 TABLET, PO, Q12H, take with 200 mg tab for total of 250 mg BID, 60 TABLET, 0 Refill(s)

voriconazole 200 mg, 1 TABLET, PO, Q12H, for 30 Days, 60 TABLET, 0 Refill(s)

P0033 CE154407 October 19, 2017 11:37 CDT

Standard Consult Format:

- Diplotype
- Phenotype
- Dosing Recommendation

Individualized Medication Recommendations

Additional Resources
& Contact Information

Pharmacogenomics

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Choose Alternative Medication or Use With Caution

| Medications | Gene | Usage | Outcome |
|----------------|--------|---|---------------------|
| ondansetron | CYP2D6 | Anti nausea | Therapeutic Failure |
| mercaptopurine | TPMT | Oncology, Chemotherapy, Gastrointestinal, Immunosuppressant | TOXICITY |
| thioguanine | TPMT | Oncology, Chemotherapy | TOXICITY |
| azaTHIOprine | TPMT | Oncology, Chemotherapy | TOXICITY |
| codeine | CYP2D6 | Pain Relief | TOXICITY |
| traMADol | CYP2D6 | Pain Relief | TOXICITY |

Additional Pharmacogenomics Resources

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 Center message pool: Pharmacogenomics
 Contacts: David Gregornik, PharmD, pager 651-629-0198

Measurements

Height: 151.7 cm
 BSA: 1.314 m²

Current Medication List

alteplase 2 mg, 2 mL, IV, PRN, PRN: line occlusion
 heparin lock 50 Units, 5 mL, IV, PRN, PRN: flush/lock
 lidocaine topical 1 application, Topically, PRN, PRN: IV start/access port
 sodium chloride 0.9% 1,000 mL See Comment, IV

Home Medication List

mercaptopurine 25 mg, 0.5 TABLET, PO, QDay, for 4 Week(s), 30 TABLET, 3 Refill(s)
 dasatinib 80 mg, 1 TABLET, PO, QDay, 30 TABLET, 6 Refill(s)
 lidocaine-prilocaine topical 1 application, Topically, PRN, for 2 Days, PRN: other, 30 g, 0 Refill(s)
 sulfamethoxazole-trimethoprim 240 mg, 1.5 TABLET, PO, M&Tu, 13.5 TABLET, 11 Refill(s)


Medications May Require Dose Adjustments

| Medications | Gene | Usage | Outcome |
|---|--------------------|----------------|---------------------|
| amiTRIPTYline (Consider alternative, may require increased dose) | CYP2C19- CYP2D6 | Antidepressant | Therapeutic Failure |
| clomiPRAMINE (Consider alternative, may require increased dose) | CYP2C19- CYP2D6 | Antidepressant | Therapeutic Failure |
| desipramine (Consider alternative (citalopram/escitalopram/desvenlafaxine), may require increased dose) | CYP2D6 | Antidepressant | Therapeutic Failure |
| doxepin (Consider alternative, may require increased dose) | CYP2C19- CYP2D6 | Antidepressant | Therapeutic Failure |
| imipramine (Consider alternative, may require increased dose) | CYP2C19- CYP2D6 | Antidepressant | Therapeutic Failure |
| nortriptyline (Consider alternative (citalopram/escitalopram/desvenlafaxine), may require increased dose) | CYP2D6 | Antidepressant | Therapeutic Failure |

Medications with evidence based gene/drug interactions

Point of Care Alerts for High Risk Gene/Drug Interactions

Discern: (1 of 1)



INTERMEDIATE METABOLIZER

Based upon the Thiopurine S-Methyltransferase (TPMT) Genotype:
Predicted Phenotype: TPMT **INTERMEDIATE METABOLIZER**
Outcome: **TOXICITY** - myelosuppression with **6-MERCAPTOPURINE**

Recommend: Start at 30-70% of normal dose, monitor

Additional Information: Clinical Pharmacist, Pharmacogenomics message pool

<http://khan.childrensmn.org/references/genetics/index.php?view=folder&folder=pgxTPMT>

ClinicalDecisionSupport@childrensmn.org

Alert Action

- Cancel mercaptopurine
- Continue
- Modify mercaptopurine

OK

Point of Care Alert – 2 Gene Results

Discern: (1 of 1)

CYP2D6 POOR METABOLIZER/CYP2C19 NORMAL METABOLIZER

Based upon the Cytochrome P450 2D6 (CYP2D6) and Cytochrome P450 2C19 (CYP2C19) Genotype
Phenotype: CYP2D6 **POOR METABOLIZER**/CYP2C19 **NORMAL METABOLIZER**
Outcome: **TOXICITY** - Increased risk of toxicity due to higher plasma concentrations following **AMITRIPTYLINE** administration.

Recommend: Avoid tricyclic antidepressant use. If AMITRIPTYLINE is indicated for this patient, recommend 50% reduction in starting dose. Strongly suggest therapeutic drug monitoring and checking an EKG.

Last EKG: 07/14/2012

Additional Information: Clinical Pharmacist, Pharmacogenomics message pool

<http://khan.childrensmn.org/references/genetics/index.php?view=folder&folder=pgxCYP2C19>

ClinicalDecisionSupport@childrensmn.org

Alert Action

Cancel amitriptyline
 Continue
 Modify amitriptyline

Add Order for:

Amitriptyline and Nortriptyline Level
 Outpatient EKG

OK

Pharmacogenomics at Children's Minnesota

- Implementations to date
 - *TPMT*: Thioguanine, 6-mercaptopurine & Azathioprine
 - *CYP2C19*: Voriconazole, Citalopram, Escitalopram
 - *CYP2D6*: Ondansetron, Tramadol, Aripiprazole, Nortriptyline, Desipramine
 - *CYP2C19* & *CYP2D6*: Amitriptyline, Imipramine, Doxepin

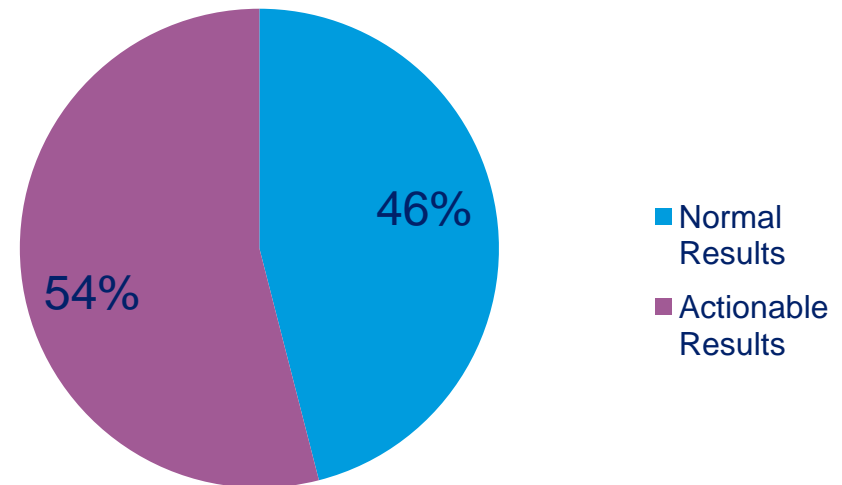
Children's Minnesota Data

- Genes implemented in EHR:
 - *TPMT*
 - *CYP2C19*
 - *CYP2D6*

As of December 31, 2017

- N = 394 patients
- 839 discrete results

Patients with Actionable Results



Success Factors

- Strong administration commitment
- Multidisciplinary oversight committee
- Dedicated pharmacist leading implementation
- Enthusiastic pharmacy service
- Customizable (Cerner) EHR
- Experienced IT analyst
- PGx laboratory with > 10 years of experience
- CPIC Guidelines

Ongoing Challenges

- Reimbursement for testing and professional services
- Educating professional staff
- Educating patients
- EHR interoperability – Cerner vs. eClinical Works

Thank You!



Pharmacogenomics Oversight Committee

- Bruce Bostrom
- David Dassenko
- Paul Jensen
- Jen Miller
- Kim Oberstar
- Robyn Reed
- Ann Samuelson
- Gunter Scharer
- Susan Sencer
- Rabindra Tambyraja
- Mike Troy
- Colleen Wherley
- Cathy Wright

Expert Resources

- Stefan Friedrichsdorf
- Steve Grapentine
- Bill Pomputius
- Ulrich Broeckel
- Mark Dunnenberger
- Cyrine Haidar
- James Hoffman

Administration/Strategy/Informatics

- Laura Madsen
- Mary Ellen Mattson
- Nancy Mendelsohn
- Trevor Sawallish
- Judy Wenzel
- Carol Wilcox
- Greg Zarambo

Questions?



"Here's my
sequence..."

New Yorker, 2000