

UF Health Precision Medicine Program: Lessons Learned After a Decade of Clinical Pharmacogenomics Implementation

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Pharmacogenomics Residency

University of Florida College of Pharmacy



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 - Go to vcu.cloud-cme.com to create an account – make sure to add your cell phone number
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| 2. Sign in using email address used above | | Click “My Evaluations” |
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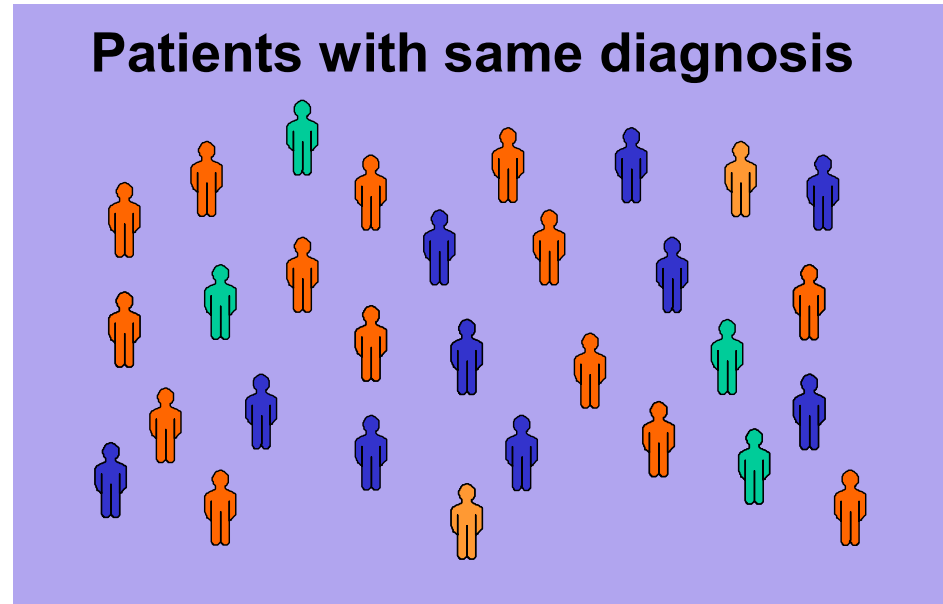
ceinfo@vcuhealth.org



<https://VCU.cloud-cme.com/WebService/SelfAttendScan.aspx?EventID=18868>

ceinfo@vcuhealth.org

Clinical Potential of Pharmacogenetics



Achieving the Clinical Potential of Pharmacogenomics

- Discovery of genetic variants influencing drug response
- Developing evidence base and tools for clinical use of pharmacogenetics
- Clinical implementation of pharmacogenetics
- Documentation of impact on clinical outcomes
- Pharmacists have and will continue to play critical roles in each of these steps



Clinical Pharmacogenetics Implementation Consortium



- TPMT, NUDT15
 - MP, TG, azathioprine
- CYP2D6
 - Codeine, tramadol, hydrocodone, oxycodone, TCAs, tamoxifen, SSRIs, ondansetron, tropisetron, atomoxetine
- CYP2C19
 - TCAs, clopidogrel, voriconazole, SSRIs, PPIs
- CYP2C9
 - Warfarin/coumarins, phenytoin, NSAIDs (in progress)
- HLA-B
 - Allopurinol, CBZ, oxcarbazepine, abacavir, phenytoin
- VKORC1
 - Warfarin/coumarins
- CYP4F2
 - Warfarin/coumarins
- CFTR
 - Ivacaftor
- HLA-A
 - CBZ
- G6PD
 - Rasburicase
- UGT1A1
 - Atazanavir
- SLCO1B1
 - Simvastatin
- IFNL3 (IL28B)
 - Interferon
- CYP3A5
 - Tacrolimus
- CYP2B6
 - Efavirenz
- RYR1, CACNA1S
 - Inhaled anesthetics
- mRNR1 (in progress)
 - Aminoglycosides
- DPYD
 - 5FU, capecitabine, tegafur

UF Health Personalized Medicine Program Launched June 25, 2012

The image is a screenshot of the UF Health website homepage. At the top, there is a navigation bar with the UF&Shands logo and menu items: Healing, Learning, Discovery, Community, and visit University of Florida. Below this is the main header area with the UF logo, the text "Division of Cardiovascular Medicine" and "Department of Medicine, College of Medicine", a search bar with the text "Search Our Site", and social media icons for Facebook, Twitter, and YouTube. A prominent orange button reads "Request a Patient Appointment: (352) 265-0820". A secondary navigation bar contains a home icon and menu items: About Us, Patient Care, Education, Research, Resources, and Contact Us. The main content area features a large article preview with the headline "UF delivers promise of personalized medicine to heart patients". Below the headline is a short paragraph: "Personalized medicine — a concept in which an understanding of a patient's genetic makeup is used to enhance treatment — has arrived at UF&Shands, the University of Florida Academic Health [...]". An orange "Read More" button with a right-pointing arrow is positioned below the text. To the right of the text is a photograph of two medical professionals, a man in scrubs and a woman in a white lab coat, looking at a computer monitor in a clinical setting. A white right-pointing arrow is overlaid on the bottom right corner of the photograph.

UF&Shands Healing Learning Discovery Community visit University of Florida

Intranet Department of Medicine COM

Search Our Site

Request a Patient Appointment: (352) 265-0820

UF Division of Cardiovascular Medicine
Department of Medicine, College of Medicine

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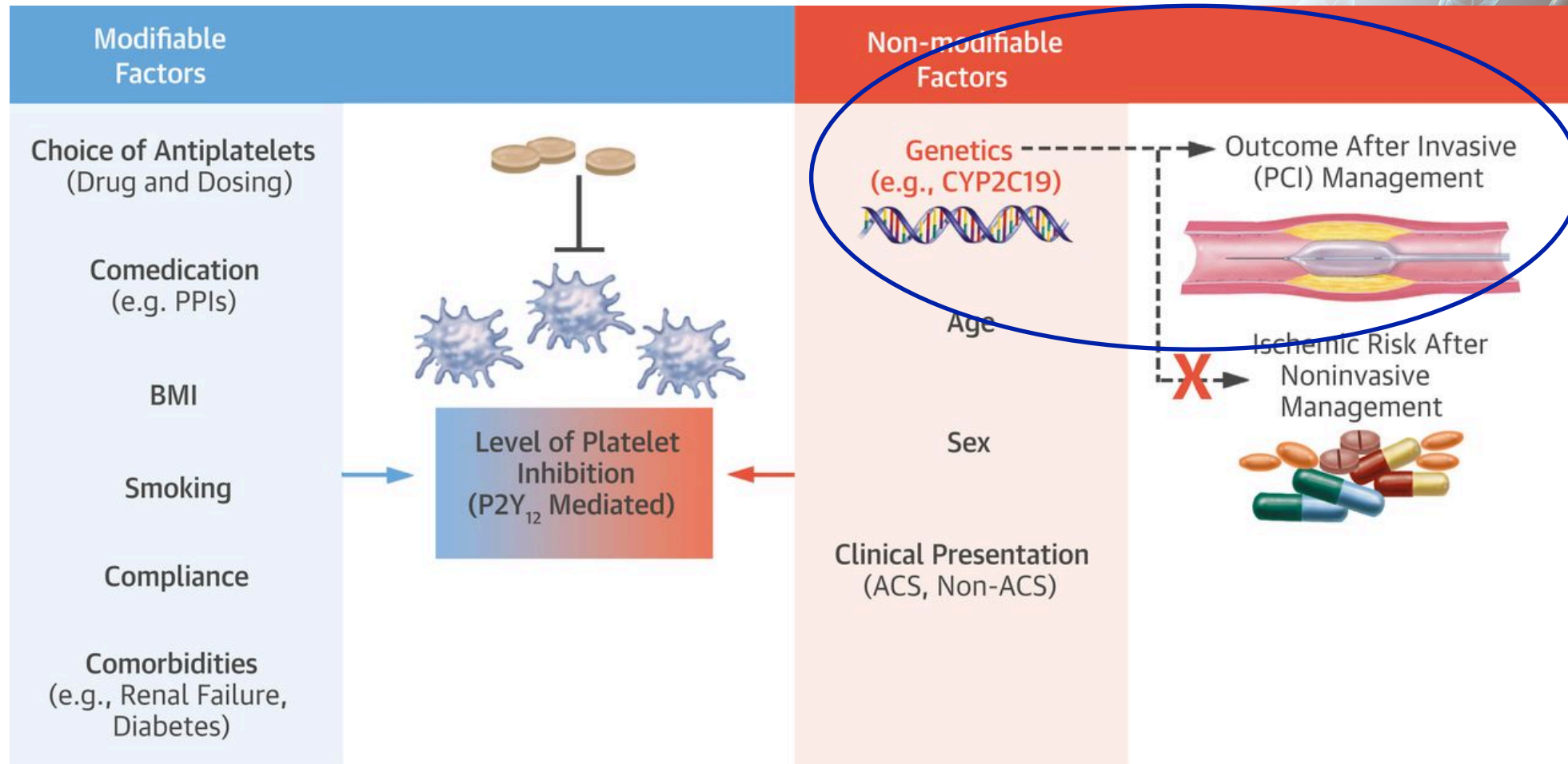
UF delivers promise of personalized medicine to heart patients

Personalized medicine — a concept in which an understanding of a patient's genetic makeup is used to enhance treatment — has arrived at UF&Shands, the University of Florida Academic Health [...]

Read More >



Clopidogrel Pilot: Clinical Implementation



Clopidogrel Pilot: Clinical Implementation

- CYP2C19 genotype test added as standard of care for patients in cath lab
 - CYP2C19 pre-selected on order sets
 - CYP2C19 genotype moves to EHR in all patients, independent of treatment with clopidogrel
- N = 1,097 patients genotyped

Weitzel KW et al. 2014. Clinical pharmacogenetics implementation: Approaches, successes, and challenges. *Am J Med Genet Part C Semin Med Genet* 166C: 56– 67

UF Health Precision Medicine Program

- Pharmacist-led multidisciplinary team within the College of Pharmacy

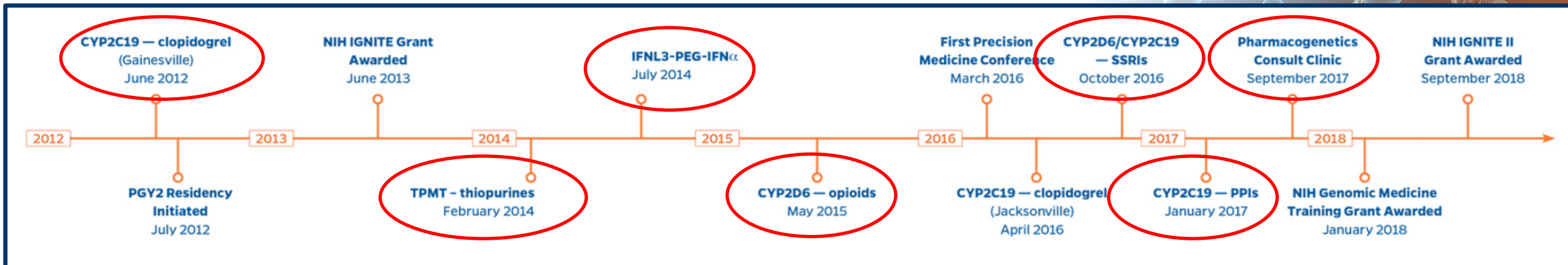


Image created by and used with permission from UF Health Precision Medicine Program
<https://precisionmedicine.ufhealth.org/>



Precision Medicine Program Clinical Pharmacogenomics Services

Research Implementation

- Clinical trials
- Inpatient or outpatient setting
- Consultation and recommendations occur per research protocol

UF Health Genotype Consults

- Any setting
- Any pharmacogene
- Follow up with note placed in chart for provider

Primary Care PGx Clinic

- Outpatient
- Internal Medicine
- 2-visit model with pharmacist
- Billing for visit
- Patient education

Clinical Decision Support

Patient and Provider Education

Pathology/
Return of Results



Communication and Documentation

Reimbursement

Monitoring and Follow Up



Available In-House Pharmacogenetic Tests

	Lab Number	Gene(s)	Medications
Single Tests	LAB2103048	CYP2D6	SSRIs, opioids, ondansetron, tamoxifen
	LAB5169	CYP2C19	SSRIs, PPIs, clopidogrel, voriconazole
	LAB5291	TPMT	Thiopurines
Panel test – “Gator PGx”	LAB12305000*	CYP2C9	Warfarin, NSAIDs
		SLCO1B1	Simvastatin
		CYP4F2	Warfarin
		CYP2C cluster	Warfarin
		CYP3A5	Tacrolimus
		CYP2D6	See above
		CYP2C19	See above

PPIs: Proton Pump Inhibitors; SSRIs: Selective Serotonin Reuptake Inhibitors;
NSAIDs: Nonsteroidal anti-inflammatory drug

*Only available out-patient

When Results Returned – Consult Note

Problem List

+ Care Coordination Note

Search for new problem + Add DxReference

Diagnosis

Encounter for pharmacogenetic testing [Edit Overview](#)

[Overview](#) CYP2D6 results available. See documentation encounter on 8/21/2020 for result interpretation

Chart Review

Encounters Notes Labs Microbiology Imaging Medications Procedures Cardiology Media Letters Referrals Other Orders

Preview Refresh (2:54 PM) Select All Deselect All Review Selected Lifetime Flowsheet Route Load Remaining Encounter Add to Bookmarks

Filters Default Filter Me Internal Medicine UF Health Internal M... Admissions Ambulatory

When	Type	Enc Dept	With
07/01/20	Documentation Encounter	UF PHARMACY	Cicali, Emily Jay

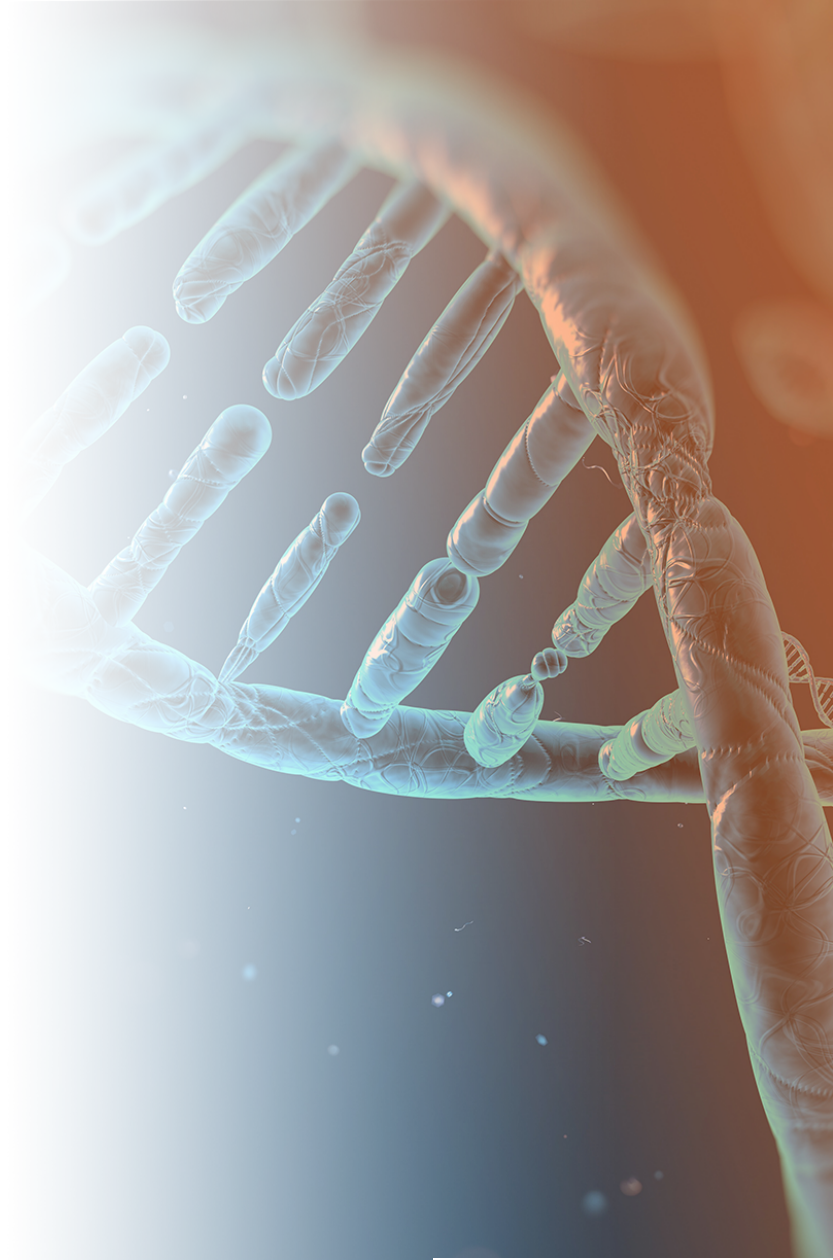
Pharmacogenetics Consultation
UF Health Precision Medicine Program

- Pharmacogene tested
- Date of consult note

Where Test Results Live

The screenshot shows a medical results review interface. At the top, there are navigation tabs: Chart Review, Review Flowsheets, Results Review (selected), Problem List, Medications, Care Everywhere, and BPA R. Below the tabs, there's a search bar and a 'Last Refresh' button. The left sidebar contains a tree view of 'ALL TOPICS' with 'GENETIC TESTING' highlighted. The main content area displays a table of results for 'PHARMACOGENETIC TE...'. The table has two rows: 'CYP2C19 Genotype' with a value of '1/17' and 'CYP2C19 Phenotype' with a value of 'Rapid Metabolizer' and a red exclamation mark icon.

PHARMACOGENETIC TE...	
CYP2C19 Genotype	1/17 *
CYP2C19 Phenotype	Rapid Metabolizer * !




Best Practice Advisories (BPA)

- CYP2C19-clopidogrel
- CYP2D6-Opioids
- CYP2C19-Proton Pump Inhibitors
- CYP2D6/CYP2C19 - Selective Serotonin Reuptake Inhibitors
- CYP2C19-Voriconazole
- CYP2D6-Ondansetron
- TPMT/NUDT15- Thiopurines

BestPractice Advisory - Pgx, Poor Metabolizer

⚠️ IMPAIRED METABOLISM ALERT

 **PHARMACOGENOMICS ALERT**

PROBLEM: This patient's CYP2C19 genotype is associated with impaired activation of the prodrug clopidogrel (Plavix) and **INCREASED RISK FOR MAJOR ADVERSE CARDIOVASCULAR EVENTS** following PCI.

RECOMMENDATIONS - IF THERE ARE NO CONTRAINDICATIONS, CHOOSE ONE OF THE FOLLOWING:


- (A) Prescribe prasugrel (EFFIENT) 10 mg daily
- OR**
- (B) Prescribe ticagrelor (BRILINTA) 90 mg twice daily

[More information on clopidogrel and CYP2C19](#)



For questions about this alert or the Personalized Medicine Program, please send us an inbasket message to "P RX UF PMP MONITORING" or call us at (352) 273-6415.

Last CYP2C19PHENO: Not on file
Last CYP2C19GENO, Collected: 5/14/2018 10:00 AM = *2/*2

Remove the following orders? _____

<input type="button" value="Remove"/>	<input type="button" value="Keep"/>	 clopidogrel (PLAVIX) tablet 75 mg 75 mg, Oral, starting today at 1710
---------------------------------------	-------------------------------------	--

Apply the following? _____

<input type="button" value="Order"/>	<input checked="" type="button" value="Do Not Order"/>	 Place order for prasugrel (EFFIENT) tablet and remove order for clopidogrel
<input type="button" value="Order"/>	<input checked="" type="button" value="Do Not Order"/>	 Place order for ticagrelor (BRILINTA) tablet and remove the clopidogrel order

The following actions have been applied: _____

✓ Sent: This advisory has been sent via In Basket

Acknowledge Reason _____

Patients Genotyped (2011 – present)

Demographics	Total Patients* (n=5,980)
Age**, mean ± SD	57 ± 18
Male‡, n(%)	3,224 (54)
Caucasian, n(%)	4,308 (72)
African American, n(%)	1,275 (21)
Hispanic or Latino, n (%)	224 (4)

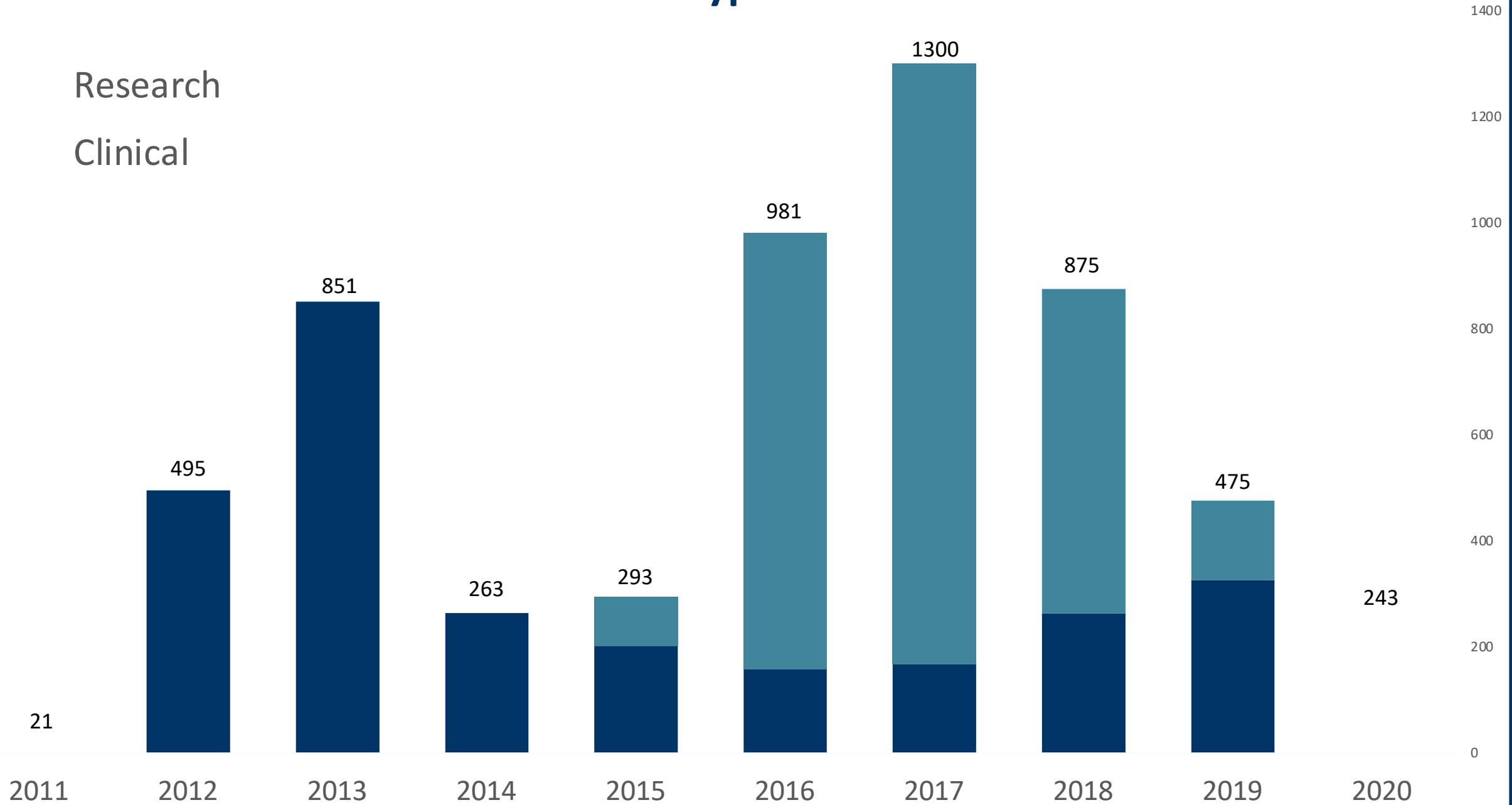
*Approx. 500 patients were genotyped for IL-28B that are not yet included in this data

**Age only available for 5,794 patients

‡ Sex only available for 5,966 patients

Total Genotypes Per Year

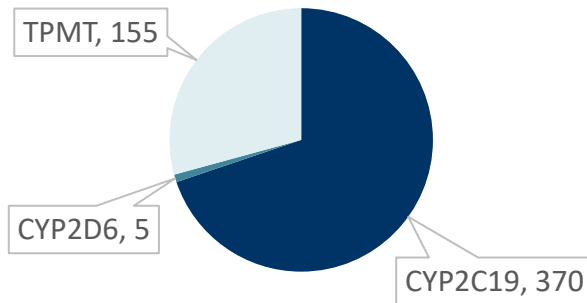
Research
Clinical



Genotype ordering per service (n>500)

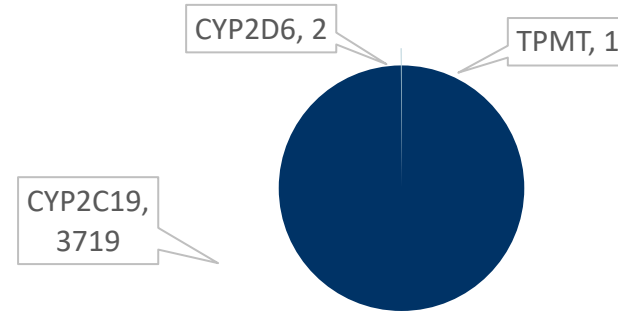
Gastrointestinal

N = 530



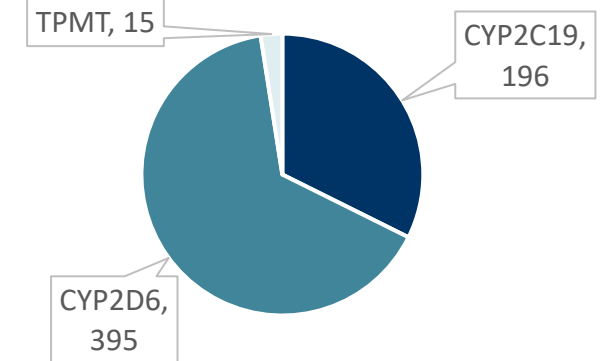
Cardiology

N = 3,722



Primary Care†

N = 606



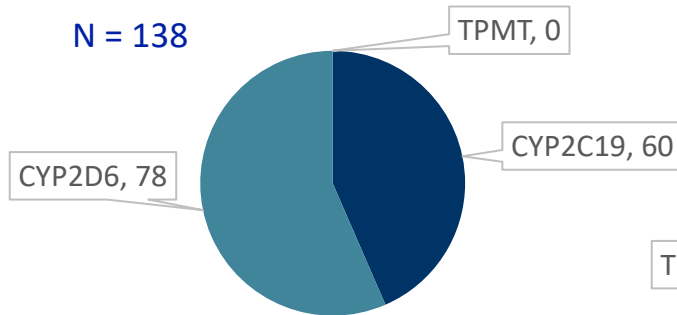
■ CYP2C19 ■ CYP2D6 ■ TPMT

†Primary Care includes both family medicine and internal medicine specialties

Genotype ordering per service (100>n<500)

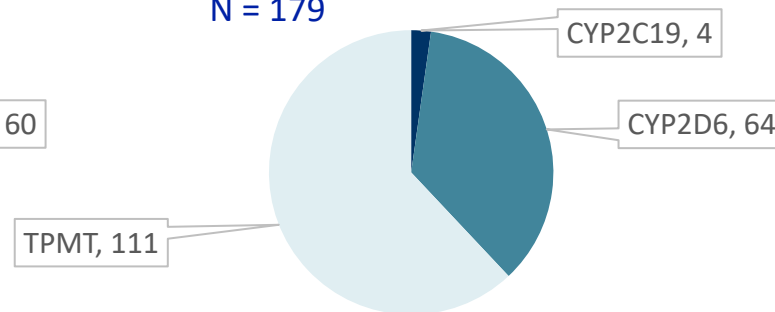
Psychiatry

N = 138



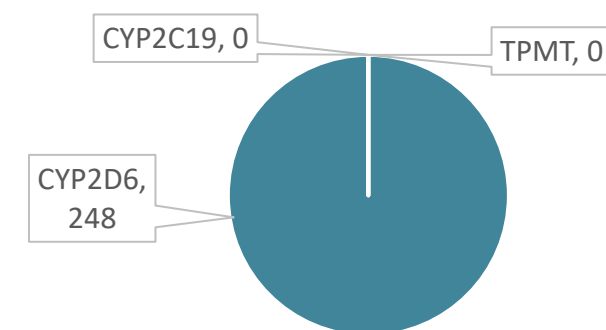
Heme/Onc

N = 179



Orthopedics

N = 248



■ CYP2C19 ■ CYP2D6 ■ TPMT

Lessons Learned

- Consistency
- Scalability
- Efficiency



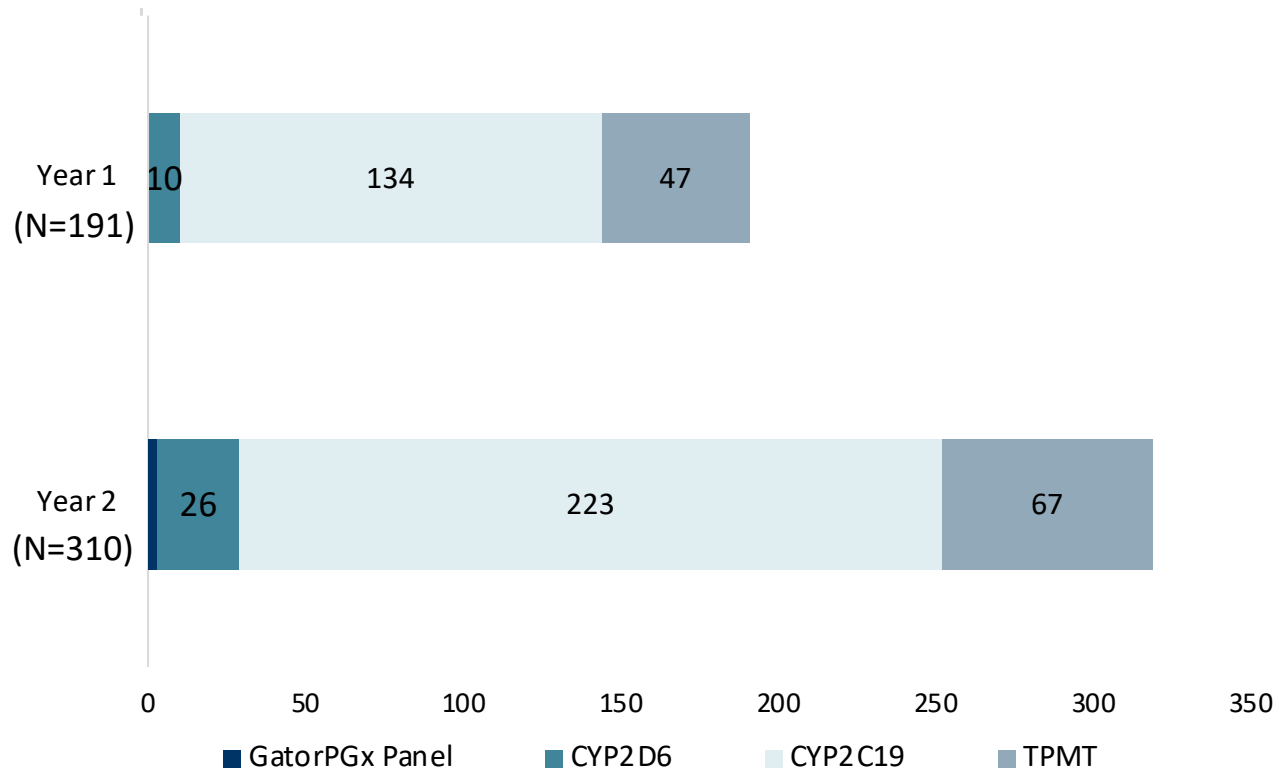
Comparison of the Last Two Years

- **Year 1** (July 1st, 2018- June 30th, 2019)
 - Clinical consult notes upon request
- **Year 2** (July 1st, 2019- June 30th, 2020)
 - Clinical consult notes for all test results

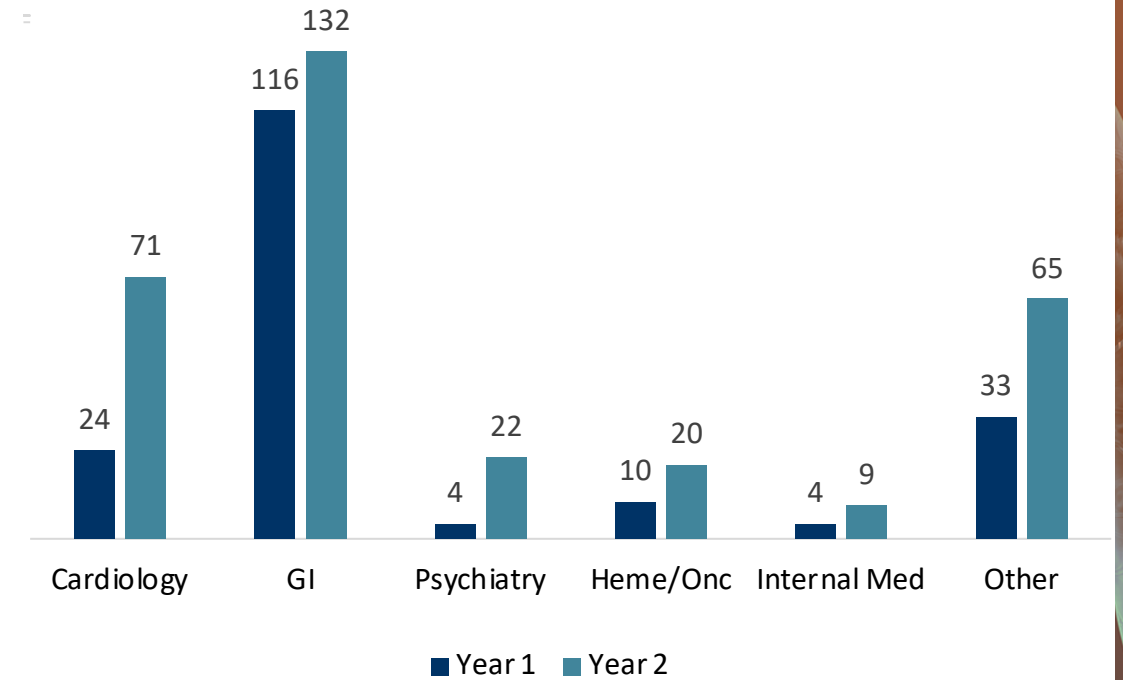


Genotype Tests Ordered

Genotype tests ordered

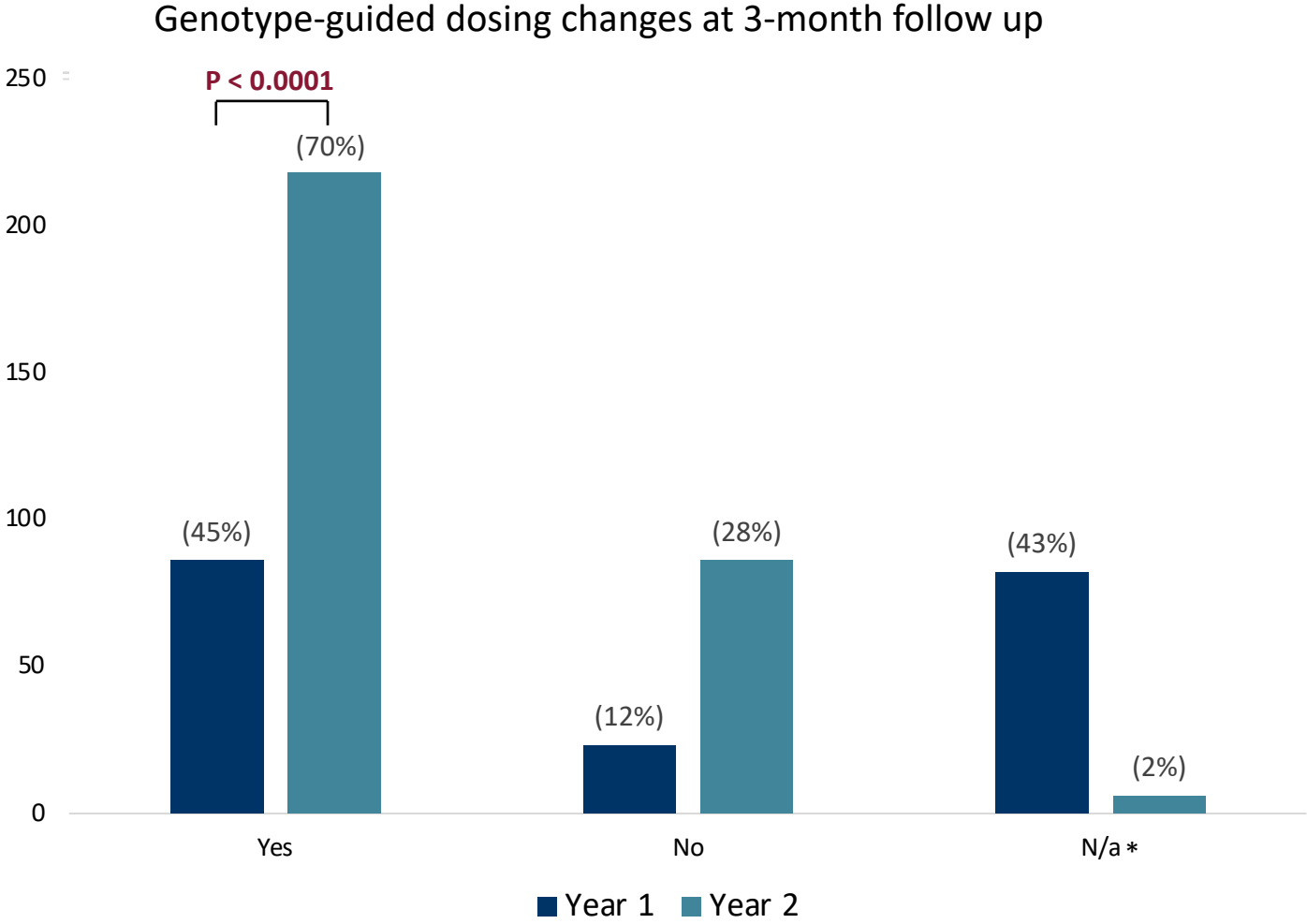


Specialty services ordering pharmacogenetic (PGx) testing



*Other specialties include rheumatology (5, 13 patients for Year 1 and Year 2 respectively), pulmonology (6 and 5), orthopedics (3 and 1), etc.

Medication Changes Consistent With Genotype



*N/A indicates patients deceased, patients lost to follow up or patients not on any drug informed by the PGx test ordered.

Lessons Learned

- Consistency
- Scalability
- Efficiency



A Systematic Approach to Information Management and Communication

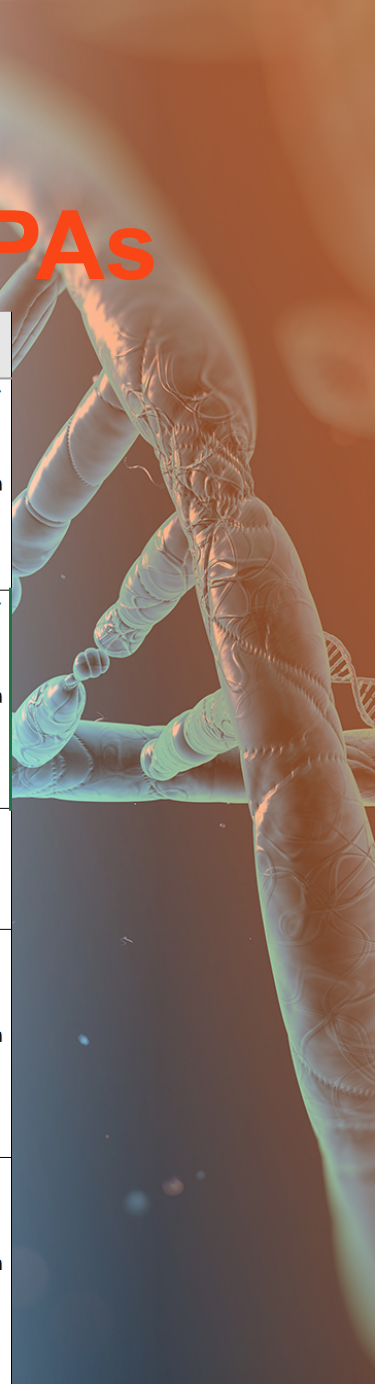
	Patient-Specific Clinical Data	Test Result Display	Medications included in clinical interpretation	Impact of Other Genes on Drug Therapy Recommendation	Phenoconversion Effects (if applicable)	Drug Therapy Recommendation(s)
Pathology Report	Identifying information only	Diplotype (primary) Phenotype	All drugs that meet evidence threshold	None	General disclaimer	None
Clinical Decision Support	Identifying information Genotype-Drug pair that triggers alert	Phenotype	Trigger drug- or drug class that meets evidence threshold	Advisory if other genotype available Informational if genotype not available	None	Targeted to specific gene-drug pair; Advisory with Immediate Actionability
Provider Report (e.g., consult note)	HPI Current Medications Allergies Interacting Medications	Phenotype (primary) Diplotype	Customized for patient's current medications that have pgx implications; +/- all relevant drugs for specific area (e.g., supportive care)	Advisory if other genotype available Informational if genotype not available	Integrated with genotype for drug therapy recommendations based on clinical phenotype	All current medications Potential future use of relevant medications Advisory with actionability when clinically appropriate
Patient Education	Identifying information only	Phenotype (primary) Diplotype	All drugs that meet evidence threshold	Informational	General disclaimer	None

A Systematic Approach to Information Management and Communication

	Patient-Specific Clinical Data	Test Result Display	Medications included in clinical interpretation	Impact of Other Genes on Drug Therapy Recommendation	Phenoconversion Effects (if applicable)	Drug Therapy Recommendation(s)
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Patient Education	Identifying information only	Phenotype (primary) Diplotype	All drugs that meet evidence threshold	Informational	General disclaimer	None

Central Database/Matrix of All Clinical Recommendations and Trigger Rules for BPAs

CYP2D6 Diplotype	CYP2D6 Phenotype	Relevant Medications	Problem Statement	BPA text Recommendation
CYP2D6 *X/*X	CYP2D6 UM	Codeine Tramadol Hydrocodone Oxycodone	This patient's CYP2D6 genotype is associated with production of excess amounts of active forms of tramadol, codeine, hydrocodone, and oxycodone. This patient is at risk for ADVERSE EVENTS such as RESPIRATORY DEPRESSION OR DEATH with these medications, even at low doses.	(A) Avoid tramadol, codeine, hydrocodone, and oxycodone and consider a non-opioid analgesic instead. OR (B) If an opioid analgesic is indicated, consider an alternative opioid such as morphine, hydromorphone, or oxymorphone, that is not affected by CYP2D6 metabolizer status
CYP2D6 *X/*X	CYP2D6 NM-UM	Codeine Tramadol Hydrocodone Oxycodone	This patient's CYP2D6 genotype is associated with production of excess amounts of active forms of tramadol, codeine, hydrocodone, and oxycodone. This patient is at risk for ADVERSE EVENTS such as RESPIRATORY DEPRESSION OR DEATH with these medications, even at low doses.	(A) Avoid tramadol, codeine, hydrocodone, and oxycodone and consider a non-opioid analgesic instead. OR (B) If an opioid analgesic is indicated, consider an alternative opioid such as morphine, hydromorphone, or oxymorphone, that is not affected by CYP2D6 metabolizer status
CYP2D6 *X/*X	CYP2D6 NM	Codeine Tramadol Hydrocodone Oxycodone	N/A	N/A
CYP2D6 *X/*X	CYP2D6 IM	Codeine Tramadol Hydrocodone	This patient's CYP2D6 genotype is associated with decreased production of active forms of tramadol, codeine, hydrocodone, and to a lesser extent, oxycodone. This patient may get LITTLE TO NO PAIN RELIEF with these medications.	(A) Avoid tramadol, codeine, and hydrocodone and consider a non-opioid analgesic instead. OR (B) If an opioid analgesic is indicated, consider an alternative opioid such as morphine, hydromorphone, or oxymorphone, that is not affected by CYP2D6 metabolizer status
CYP2D6 *X/*X	CYP2D6 PM	Codeine Tramadol Hydrocodone	This patient's CYP2D6 genotype is associated with significantly decreased production of active forms of tramadol, codeine, hydrocodone, and to a lesser extent, oxycodone. This patient may get LITTLE TO NO PAIN RELIEF with these medications.	(A) Avoid tramadol, codeine, and hydrocodone and consider a non-opioid analgesic instead. OR (B) If an opioid analgesic is indicated, consider an alternative opioid such as morphine, hydromorphone, or oxymorphone, that is not affected by CYP2D6 metabolizer status



Central Database/Matrix of All Clinical Recommendations and Trigger Rules for BPAs

CYP2D6 Diplotype	CYP2D6 Phenotype	Relevant Medications	Problem Statement	BPA text Recommendation
CYP2D6 *X/*X	CYP2D6 UM	Codeine Tramadol Hydrocodone Oxycodone	This patient's CYP2D6 genotype is associated with production of excess amounts of active forms of tramadol, codeine, hydrocodone, and oxycodone. This patient is at risk for ADVERSE EVENTS such as RESPIRATORY DEPRESSION OR	(A) Avoid tramadol, codeine, hydrocodone, and oxycodone and consider a non-opioid analgesic instead. OR (B) If an opioid analgesic is indicated, consider an alternative opioid such
			may get LITTLE TO NO PAIN RELIEF with these medications.	(B) If an opioid analgesic is indicated, consider an alternative opioid such as morphine, hydromorphone, or oxymorphone, that is not affected by CYP2D6 metabolizer status

Complexity:

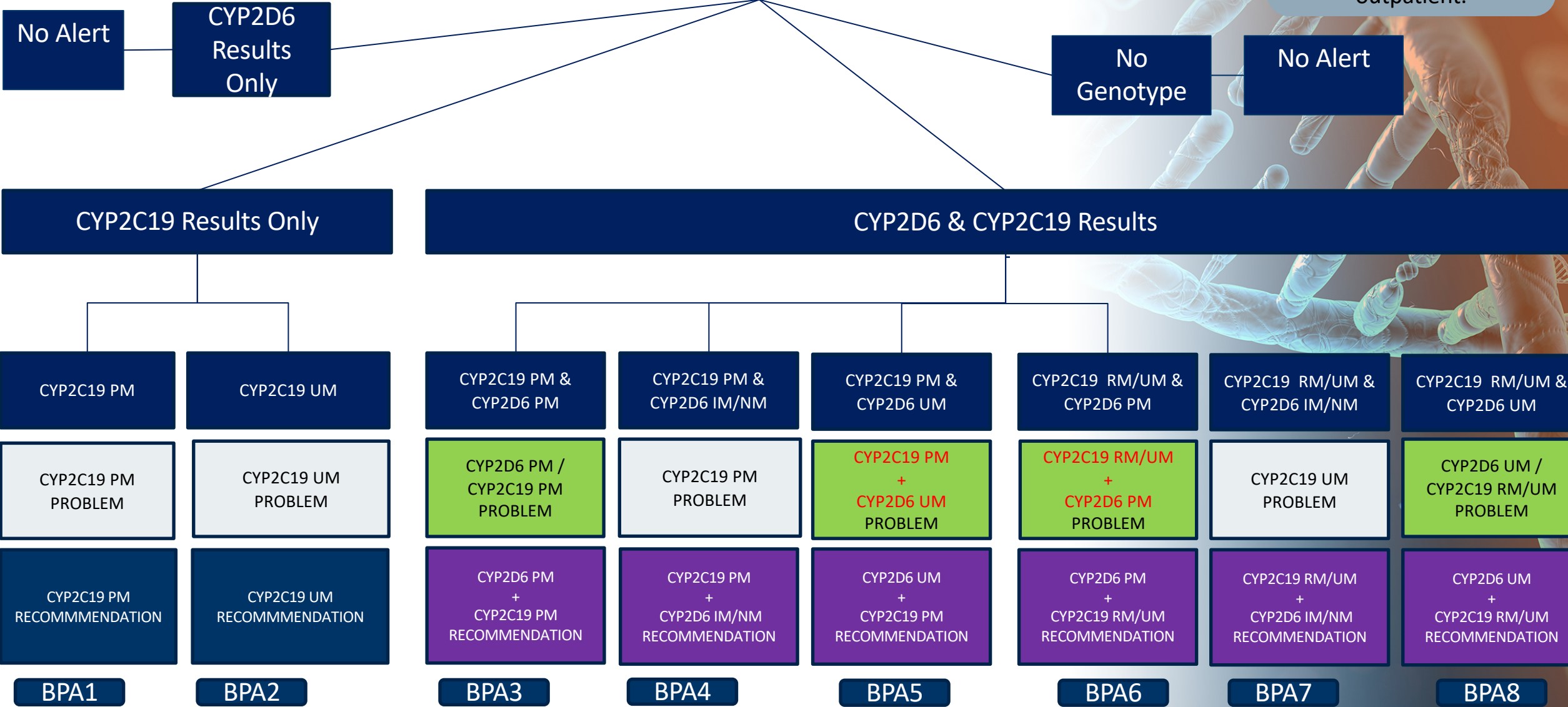
2 or more genes affect a single drug

Interpatient variability in available genotype data



CYP2C19 SSRI ordered

BPAs will fire once per provider per encounter for both inpatient and outpatient.



Multi-Gene/Drug Scenarios

CYP2D6 Diplotyp	CYP2D6 Phenotyp	CYP2C19 Diplotyp	CYP2C19 Phenotyp	Relevant Medication	Problem Statement	BPA Text (Both Genes)
CYP2D6 *X/*X	CYP2D6 PM	CYP2C19 *X/*X	CYP2C19 PM	sertraline, escitalopram, citalopram, paroxetine, fluvoxamine	This patient's CYP2D6 and CYP2C19 poor metabolizer statuses are associated with increased levels of sertraline, escitalopram, citalopram, paroxetine, and fluvoxamine and increased risk of adverse effects	(A) Avoid sertraline, escitalopram, citalopram, paroxetine, and fluvoxamine or decrease dose by 50% if use is warranted. (B) Consider non-SSRI antidepressant such as desvenlafaxine, duloxetine, bupropion, or others.
CYP2D6 *X/*X	CYP2D6 UM	CYP2C19 *X/*X	CYP2C19 PM	sertraline, escitalopram, citalopram	This patient's CYP2C19 poor metabolizer status is associated with increased levels of sertraline, escitalopram, and citalopram and increased risk of adverse effects. Their CYP2D6 ultra rapid metabolizer status is associated with decreased levels of paroxetine and increased risk of inadequate response	(A) Avoid sertraline, escitalopram, and citalopram or decrease dose by 50% if use is warranted. (B) Avoid paroxetine. (C) Consider fluoxetine or non-SSRI antidepressant such as venlafaxine, duloxetine, bupropion, or others.
	CYP2D6 UM	CYP2C19 *X/*X	CYP2C19 PM	paroxetine	This patient's CYP2D6 ultra rapid metabolizer status is associated with decreased levels of paroxetine and increased risk of inadequate response. Their CYP2C19 poor metabolizer status is associated with increased levels of sertraline, escitalopram, and citalopram and increased risk of adverse effects	(A) Avoid paroxetine (B) Avoid sertraline, escitalopram, and citalopram or decrease dose by 50% if use is warranted. © Consider fluoxetine or non-SSRI antidepressant such as venlafaxine, duloxetine, bupropion, or others.
CYP2D6 *X/*X	CYP2D6 PM	CYP2C19 *X/*X	CYP2C19 RM/UM	sertraline, escitalopram, citalopram	This patient's CYP2C19 rapid or ultra rapid metabolizer status is associated with decreased levels of sertraline, escitalopram, and citalopram and increased risk of inadequate response. Their CYP2D6 poor metabolizer status is associated with increased levels of paroxetine and fluvoxamine and increased risk of adverse effects	(A) Avoid escitalopram, citalopram, and potentially sertraline. (B) Avoid paroxetine and fluvoxamine or decrease dose by 50% if use is warranted. (C) Consider non-SSRI antidepressant such as desvenlafaxine, duloxetine, bupropion, or others.

Figure 2. Example of updated SSRI BPA incorporating both the CYP2C19 and CYP2D6 phenotype.

Problem Result Recommendations

BestPractice Advisory – PGx

PHARMCOGENOMICS ALERT

PROBLEM: This patient's CYP2C19 poor metabolizer status is associated with increased levels of sertraline, escitalopram, and citalopram and increased risk of adverse effects.

Their CYP2D6 ultrarapid metabolizer status is associated with decreased levels of paroxetine and increased risk of inadequate response.

RECOMMENDATIONS:

- (A) Avoid sertraline, escitalopram, and citalopram or decrease dose by 50% if use is warranted.
- (B) Avoid paroxetine.
- (B) Consider fluoxetine or non-SSRI antidepressant such as venlafaxine, duloxetine, bupropion, or others.

[More information on SSRIs and CYP2C19/CYP2D6](#)

Questions? Message "P RX UF PMP MONITORING" or call (352) 273-6415

Last CYP2C19PHENO, Collected: 4/9/2019 10:00 AM = Poor Metabolizer
Last CYP2D6PHENO, Collected: 4/9/2019 10:00 AM = Ultrarapid Metabolizer

Remove the following orders?

<input type="button" value="Remove"/>	<input type="button" value="Keep"/>	Sertraline (ZOLOFT) tablet 100 mg 100 mg, Oral, DAILY
---------------------------------------	-------------------------------------	--

The following actions have been applied:

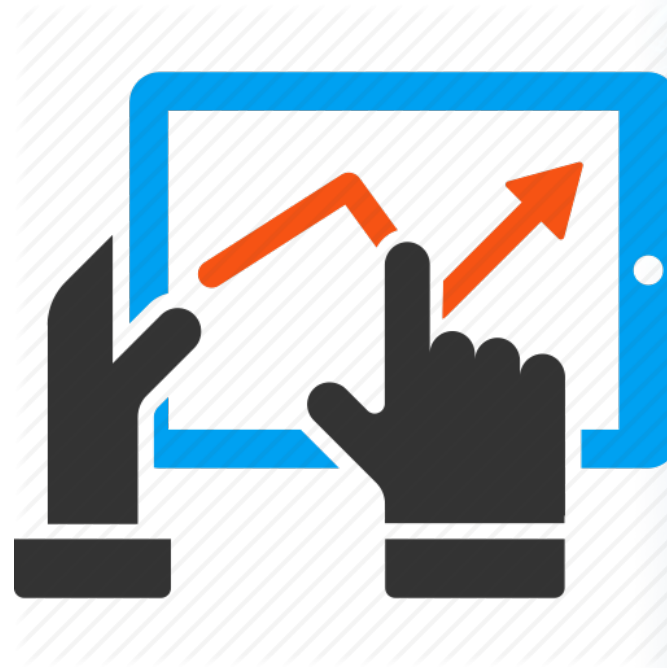
- ✓ Sent: This advisory has been sent via In Basket

Acknowledge Reason



Metrics

- Monitor:
 - Pharmacogenetic tests ordered
 - BPAs that fire
 - Action taken when BPAs fire
 - Recommendations followed
 - Reimbursement



Metrics

- Monitor:
 - Pharmacogenetic tests ordered
 - BPAs that fire
 - Action taken when BPAs fire
 - Recommendations followed
 - Reimbursement
- Upkeep:
 - Return of results
 - Documentation
- Identify education needs




Improve quality of BPA data collection for research and quality improvement from

May 2020 – present

N = 180 BPA Fires

- 25% CYP2C19 RM/UM - Proton Pump Inhibitors
- 24% CYP2C19 IM – Clopidogrel
- 15% no TPMT genotype - Thiopurines

BestPractice Advisory - Greyhair, Curly

 **PHARMACOGENOMICS ALERT**

PROBLEM: This patient's CYP2C19 genotype is associated with impaired activation of the prodrug clopidogrel (Plavix) and **INCREASED RISK FOR MAJOR ADVERSE CARDIOVASCULAR EVENTS** following PCI.

RECOMMENDATIONS - IF THERE ARE NO CONTRAINDICATIONS, CHOOSE ONE OF THE FOLLOWING:

ⓘ FOLLOWING:


- (A) Prescribe prasugrel (EFFIENT) 10 mg daily
- OR**
- (B) Prescribe ticagrelor (BRILINTA) 90 mg twice daily

[More information on clopidogrel and CYP2C19](#)


For questions about this alert or the Personalized Medicine Program, please send us an inbasket message to "P RX UF PMP MONITORING" or call us at (352) 273-6415.


Last CYP2C19PHENO, Collected: 6/27/2019 6:00 AM = Poor Metabolizer
Last CYP2C19GENO, Collected: 6/16/2019 6:00 AM = *5/*5

Remove the following orders? _____

 clopidogrel (PLAVIX) 75 MG Oral Tablet
Take 1 tablet by mouth daily. Disp-, E-Prescribing

Apply the following? _____

 Place order for prasugrel (EFFIENT) tablet and remove order for clopidogrel

 Place order for ticagrelor (BRILINTA) tablet and remove the clopidogrel order

The following actions have been applied: _____

✓ Sent: This advisory has been sent via In Basket

Acknowledge Reason _____

Lessons Learned

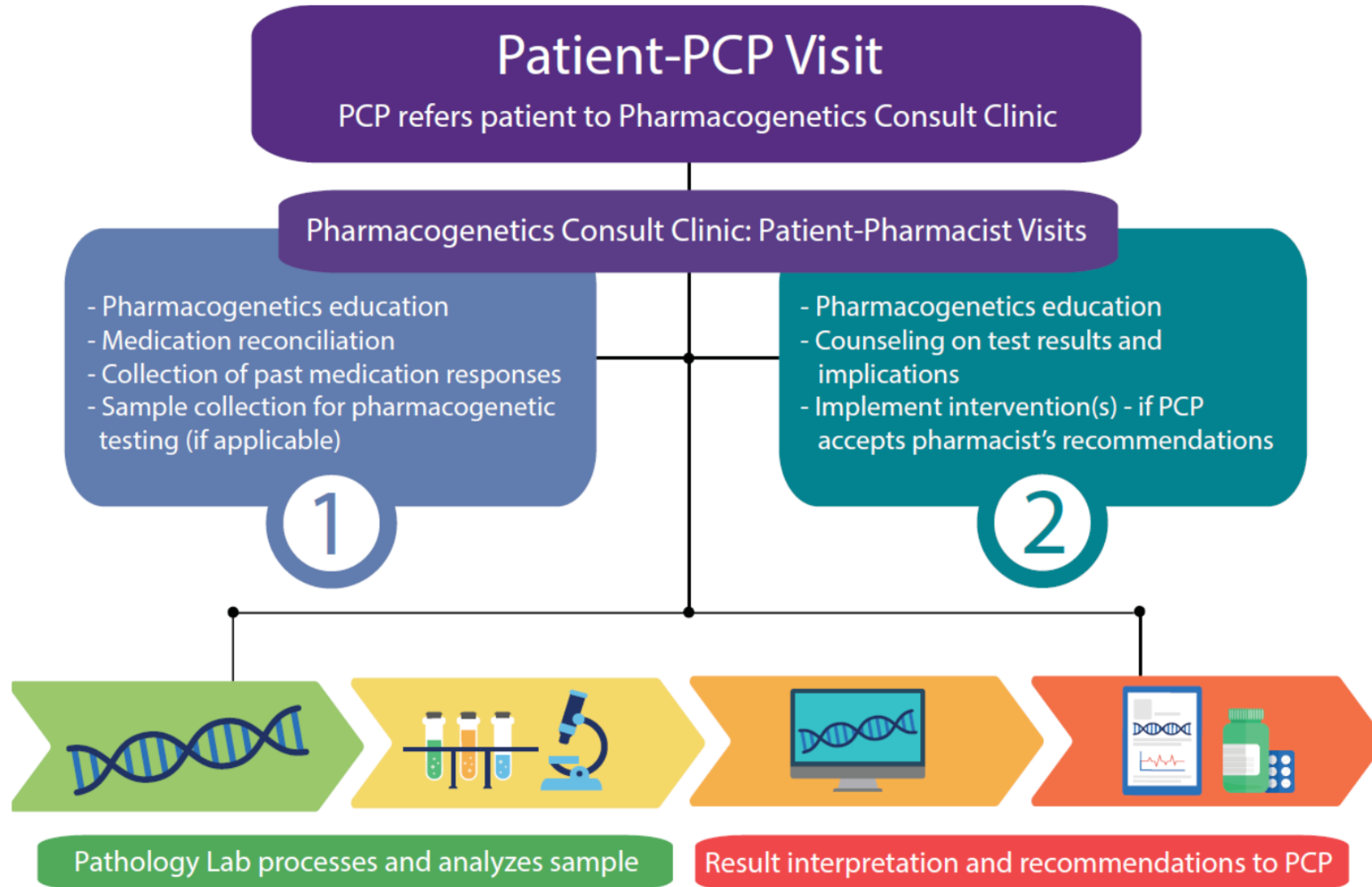
- Consistency
- Scalability
- Efficiency



Pharmacogenomics in Primary Care

Medication(s)	Gene	CPIC Guideline	PGx in US FDA Label
Codeine/Tramadol	<i>CYP2D6</i>	X	X
Celecoxib	<i>CYP2C9</i>	X	X
SSRIs	<i>CYP2C19</i> and <i>CYP2D6</i>	X	X
Venlafaxine	<i>CYP2D6</i>		X
Proton Pump Inhibitors	<i>CYP2C19</i>	X	X
Clopidogrel	<i>CYP2C19</i>	X	X
Simvastatin	<i>SLCO1B1</i>	X	X
Aripiprazole, risperidone	<i>CYP2D6</i>		X
Carbamazepine, Oxcarbazepine, Phenytoin	<i>CYP2C9</i> , <i>HLA-A</i> , <i>HLA-B</i>	X	X
Atomoxetine	<i>CYP2D6</i>	X	X
Ondansetron	<i>CYP2D6</i>	X	X
Tamoxifen	<i>CYP2D6</i>	X	

Table adapted from: K Wiisanen et al. *Pharmacogenomics*. 2019;20:1103.



Build A PGx Business/Practice Model

- Payment for PGx testing and pharmacist clinical services
 - Fee-for-service
 - Capitated and shared-risk, shared-reward systems
 - Blended payment structures
 - MTM billing codes
 - Billing incident-to or in collaboration with physician



Word cloud created by presenter with Microsoft Office

Build A PGx Business/Practice Model

Pre-Implementation

Collaborative Practice Agreement between pharmacist and physician

Patient Identification

At point of care/point of dispensing or provider referral

Pharmacist Visit 1

Medication history and buccal swab for PGx testing

Between Visits

Pharmacist receives result; recommendations to physician

Pharmacist Visit 2

Pharmacist reviews recommendations and drug therapy changes

Education
Feedback
Monitoring

Build A PGx Business/Practice Model

Table 1. Sample Patient Breakdown by Condition and Payer

Site	Payers	Depression	Chronic Pain	Pain or Depression
Sample Clinic	Medicare	6.5 %	5.5 %	10.1 %
	All	15.8 %	9.7 %	22.6 %

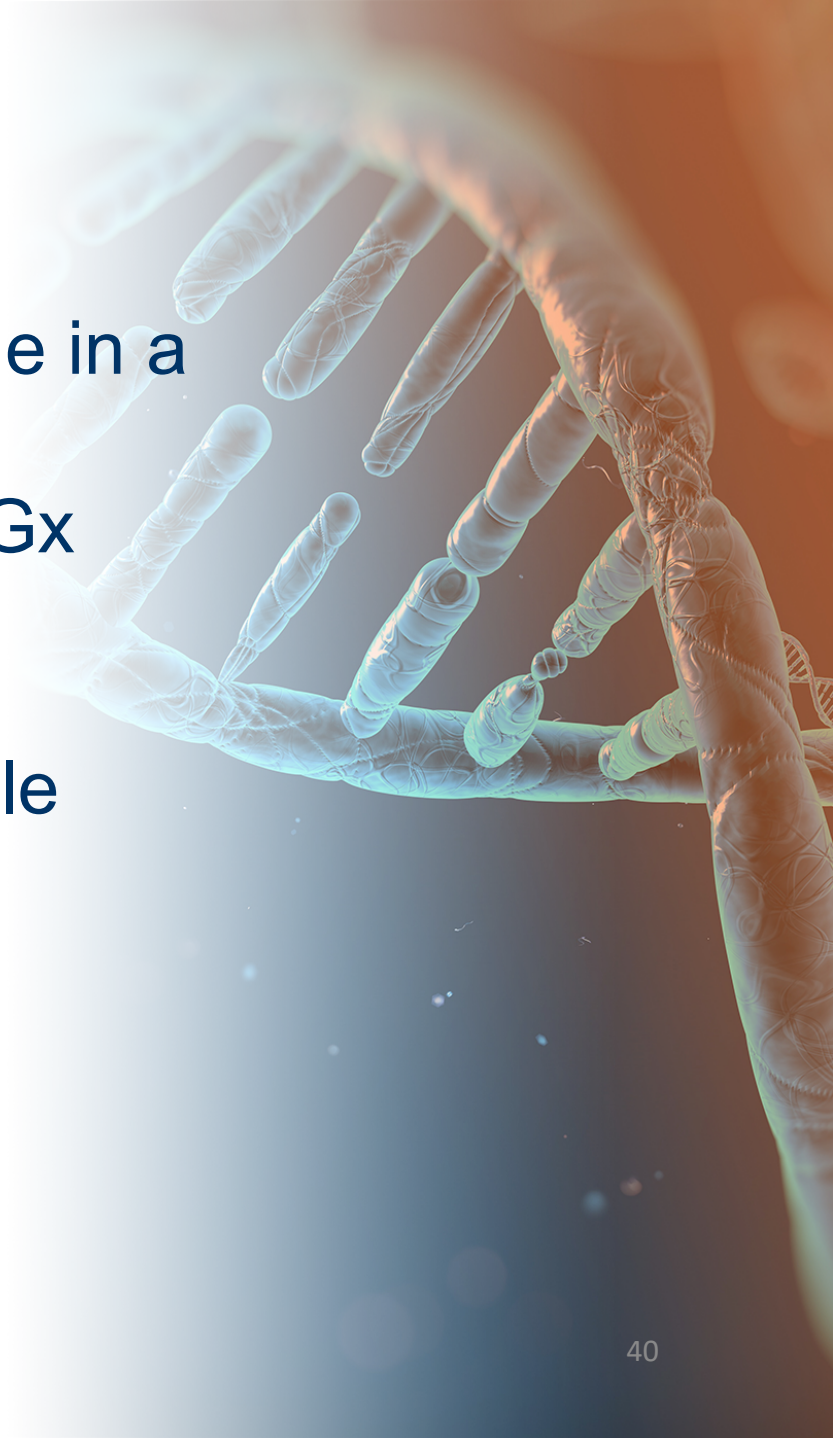
Table 2. Sample Patient Breakdown by Medication and Payer

Site	Payers	Codeine or tramadol	Oxycodone or Hydrocodone	SSRI	TCA	PPI	Any of these Medications
Sample Clinic	Medicare	2.3%	2.8 %	4.3%	0.7 %	7.4 %	13.2 %
	All	4.6 %	6.5 %	12.4 %	1.7 %	16.7 %	33.5 %



Conclusion

- Pharmacogenetics implementations are feasible in a clinical setting
- Pharmacist leadership is essential in clinical PGx services
- Education is an important catalyst to enable expansion of pharmacogenetics on a large scale
- Lessons learned
 - Consistency
 - Scalability
 - Efficiency



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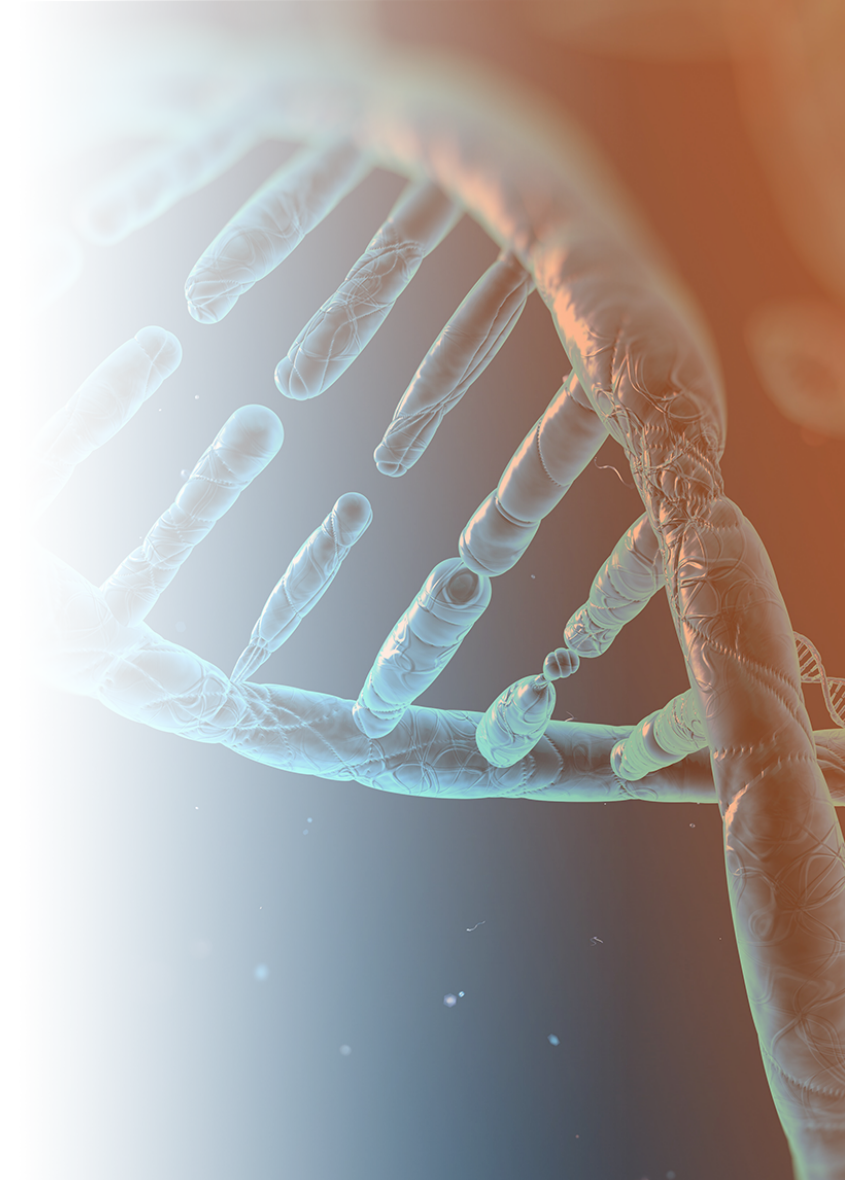
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Questions?



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