EHR Characteristics in Opioid Use Disorders

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Pain is a more terrible lord of mankind than even death itself.
Albert Schweitzer, MD, 1931.

Topics to be Discussed

Risk for OUD among Geisinger patients with non-progressive musculo-skeletal pain who are prescribed opioids for months.

Genetics of opioid dose at Geisinger.

Neonatal opioid withdrawal syndrome at Geisinger

~40-50 years ago, research (see for example Marks & Sachar, 1973) indicated that physicians were too restrictive in prescribing opioids for severe pain, resulting in undue suffering.

But, beginning ~30 years ago, a few pharmaceutical companies (Purdue) distributed widely to physicians poorly designed studies which seemed to indicate that risk for addiction was negligible if opioids were given for chronic non-progressive pain.

The resulting increase in opioid prescriptions has led (predictably) to a large increase in opioid addiction.

ADDICTION RARE IN PATIENTS TREATED WITH NARCOTICS

To the Editor: Recently, we examined our current files to determine the incidence of narcotic addiction in 39,946 hospitalized medical patients[1] who were monitored consecutively. Although there were 11,882 patients who received at least one narcotic preparation, there were only four cases of reasonably well documented addiction in patients who had no history of addiction. The addiction was considered major in only one instance. The drugs implicated were meperidine in two patients,[2] Percodan in one, and hydromorphone in one. We conclude that despite widespread use of narcotic drugs in hospitals, the development of addiction is rare in medical patients with no history of addiction.

New England Journal of Medicine 302: 123, 1980

JANE PORTER
HERSHEL JICK, M.D.

In the 1990s, physicians began to prescribe opioids for non-progressive musculo-skeletal pain, leading to increases in OUD.

Opioids are very good for *acute pain;* they should not be used for **chronic pain**, due to side effects, tolerance and risk for OUD.

Effect of Opioid vs Nonopioid Medications on Pain-Related Function in Patients With Chronic Back Pain or Hip or Knee Osteoarthritis Pain
The SPACE Randomized Clinical Trial

JAMA, 2018

Erin E. Krebs, MD, MPH; Amy Gravely, MA; Sean Nugent, BA; Agnes C. Jensen, MPH; Beth DeRonne, PharmD; Elizabeth S. Goldsmith, MD, MS; Kurt Kroenke, MD; Matthew J. Bair; Siamak Noorbaloochi, PhD

Outcome	Opioid Group, Mean (SD) (n = 119)	Nonopioid Group, Mean (SD) (n = 119)	Between-Group Difference (95% CI)[a]	Overall *P* Value[b]
Pain-Related Function (Primary Outcome)				
BPI interference scale (range, 0-10; higher score = worse)[c]				
Baseline	5.4 (1.8)	5.5 (2.0)	−0.1 (−0.6 to 0.4)	.58
3 mo	3.7 (2.1)	3.7 (2.2)	0.0 (−0.6 to 0.6)	
6 mo	3.4 (2.1)	3.6 (2.4)	−0.2 (−0.8 to 0.4)	
9 mo	3.6 (2.2)	3.3 (2.4)	0.4 (−0.2 to 1.0)	
12 mo	3.4 (2.5)	3.3 (2.6)	0.1 (−0.5 to 0.7)	
Pain Intensity (Secondary Outcome)				
BPI severity scale (range, 0-10; higher score = worse)[d]				
Baseline	5.4 (1.5)	5.4 (1.2)	0.0 (−0.4 to 0.3)	.03
3 mo	4.3 (1.8)	4.0 (1.7)	0.3 (−0.2 to 0.7)	
6 mo	4.1 (1.8)	4.1 (1.9)	0.0 (−0.5 to 0.5)	
9 mo	4.2 (1.7)	3.6 (1.7)	0.7 (0.2 to 1.2)	
12 mo	4.0 (2.0)	3.5 (1.9)	0.5 (0.0 to 1.0)	

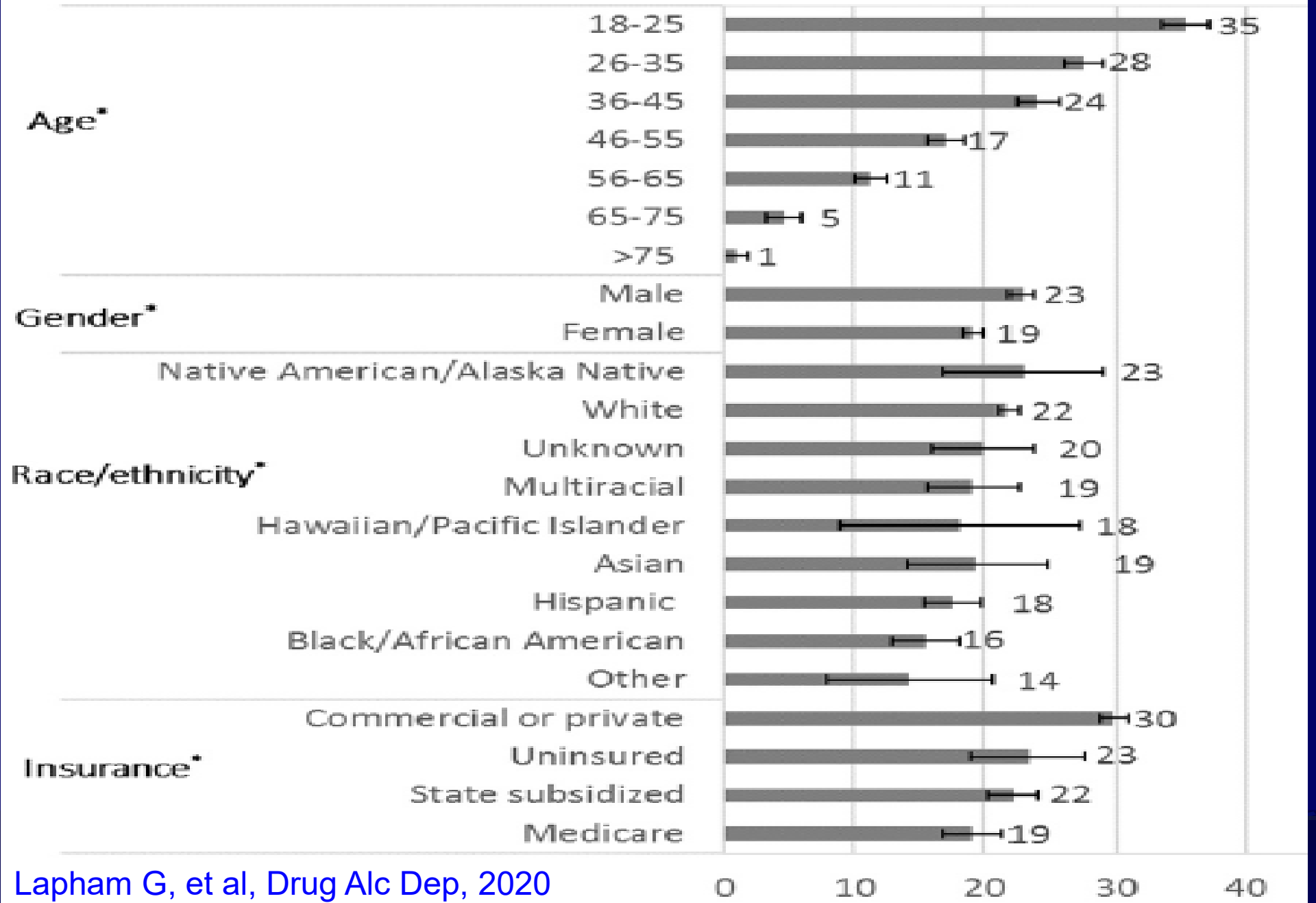
OUD Epidemiology in 6 Healthcare Systems

Characteristics of primary care patients with at least 2 visits to primary care during the 3-year period (Oct 1, 2013-Sept 30, 2016).

Lapham G, et al,
Drug Alc Dep, 2020

	Documented OUD (13,942)		No Documented OUD (1,354,662)		
	N	%	N	%	p-value
Any non-cancer pain diagnosis	12,420	(89.1)	1,019,994	(75.3)	< 0.001
Any mental health disorder diagnosis	11,225	(80.5)	462,151	(34.1)	< 0.001
Tobacco use disorder	8,395	(60.2)	214,561	(15.8)	< 0.001
Alcohol use disorder	3,965	(28.4)	47,711	(3.5)	< 0.001
Other SUD disorder diagnosis	7,346	(52.7)	27,103	(2.0)	< 0.001
Cannabis use disorder	2,307	(16.5)	13,314	(1.0)	< 0.001
Stimulant disorder	2,520	(18.1)	6,538	(0.5)	< 0.001
Other drug use disorders	6,157	(44.2)	12,939	(1.0)	< 0.001
Opioid overdose	511	(3.7)	622	(0.0)	< 0.001

% OUD Patients Treated with Buprenorphine



Lapham G, et al, Drug Alc Dep, 2020

Geisinger: An Integrated Health Care Delivery System

Clinical Enterprise

14 hospitals
~70 community practices
2 million patients
EPIC EHR since 1996
Standardized diagnostics
DNA & biofluids bank (MyCode)
Accredited medical school

Patient Population

Stable NE PA population
97% European ancestry
Engaged patients
Whole exome sequencing & array genotyping of patient population in progress: 145K samples completed.

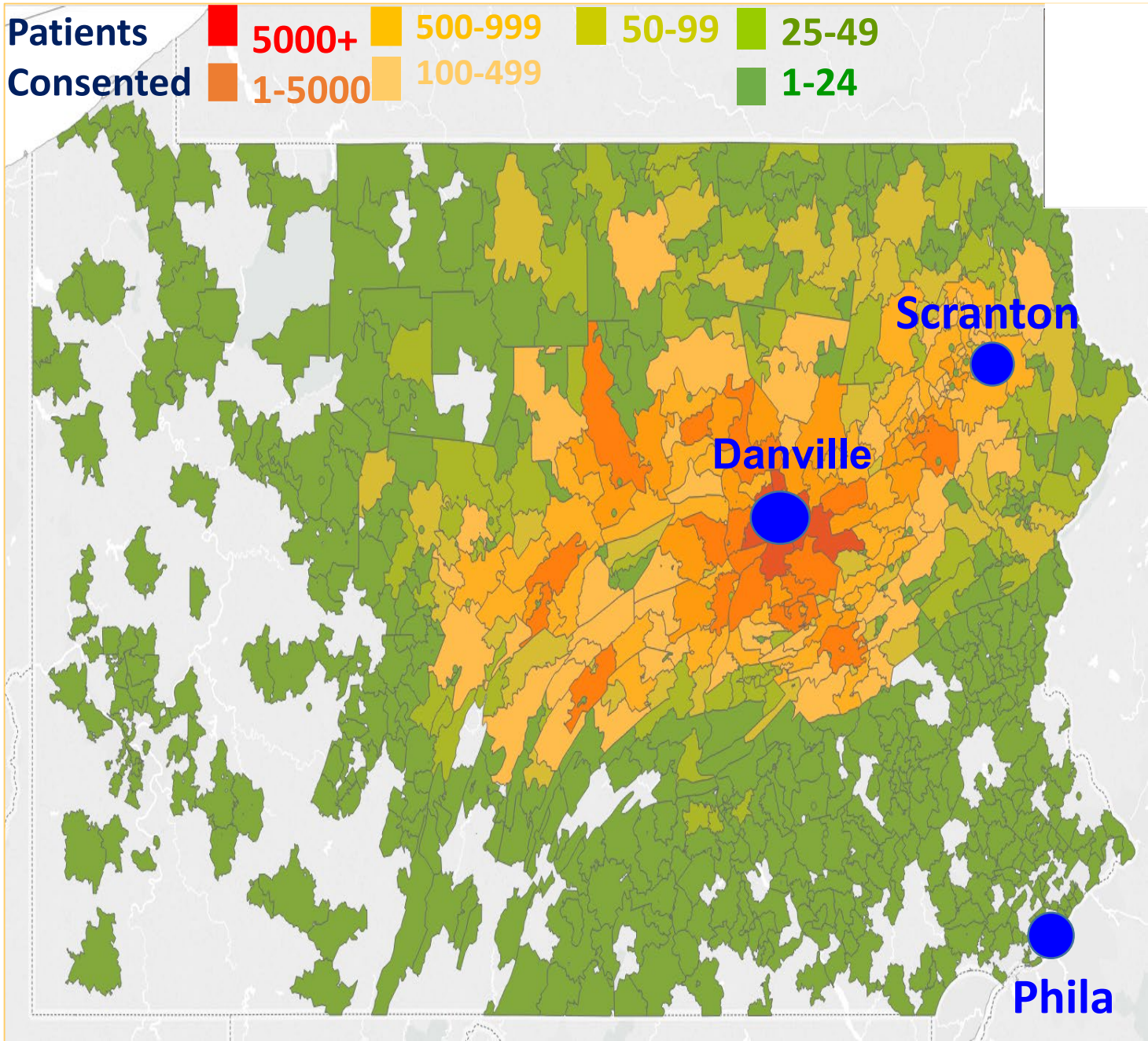
Geisinger Biobank (MyCode) Participants

Patient consent occurs during an outpatient visit.

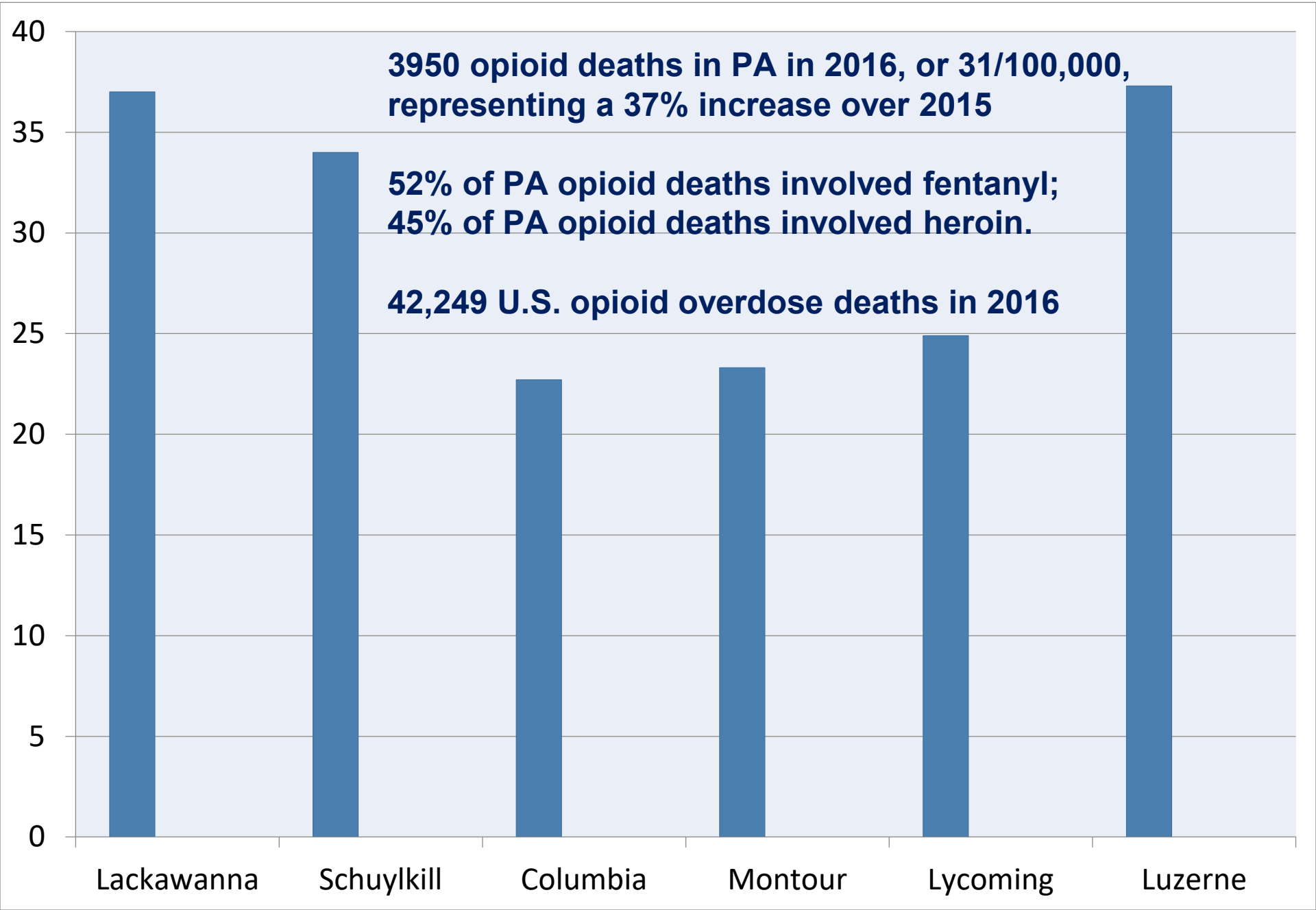
Consent creates order for a research blood tube to be drawn at next clinically-indicated phlebotomy.

Re-contact allowed for return of medically-actionable results from DNA sequencing & for research purposes.

>300,000 patient participants



Opioid Overdose Deaths by PA County in 2016 per 100,000 Persons



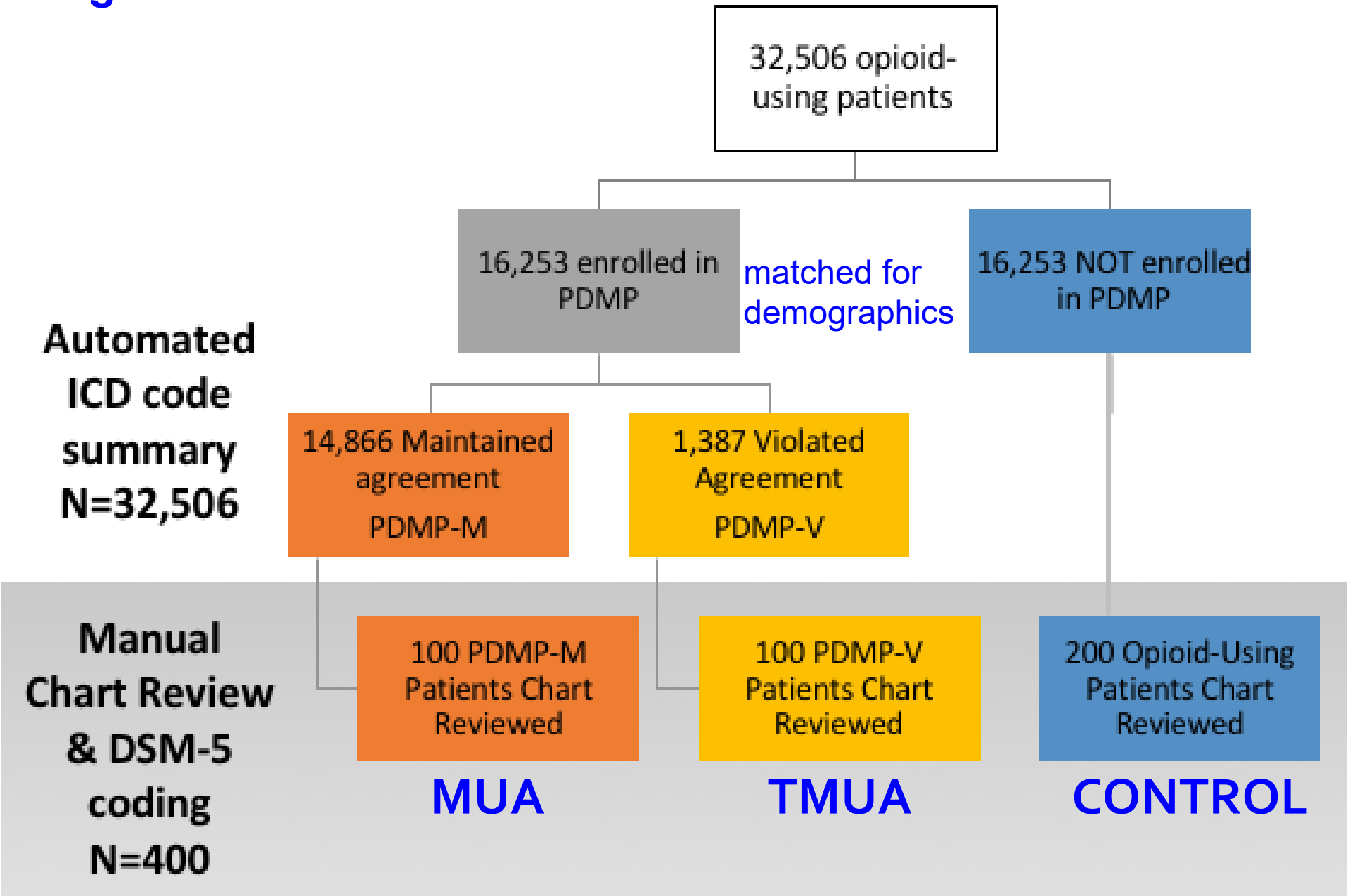
Geisinger requires opioid-treated chronic non-progressive pain patients to follow guidelines for opioid use through a Prescription Drug Medication Program (PDMP), including a Medication Use Agreement (MUA; take only opioid provided by designated Geisinger MD; random UDSs; 'lost' medications will not be replaced; minimum twice monthly clinic visits, etc.).

An MUA (site-specific ICD code) is often instituted by the primary care physician if opioid misuse is suspected. The MUA is either maintained (PDMP-M) or it is violated and terminated (PDMP-V).

We hypothesized that PDMP-M and PDMP-V groups would have electronic health record (EHR) evidence of OUD.

We reviewed 100 PDMP-M, 100 PDMP-V and 200 control EHRs from patients treated at least 90 days with opioids (typically for chronic, musculo-skeletal non-progressive pain). Patients were matched on age, duration of opioid use, gender, ethnicity (>95% European ancestry). Patients with metastatic cancer or other types of progressive pain were excluded.

Geisinger Patients Treated with Opioids for >60 Days for Non-Progressive Musculo-skeletal Pain



Demographics for Chart Review Sample of PDMP and Control Patients

	PDMP	Control	p-value
Sample Demographics			
N	200	200	
Male	84	79	6.12E-01
Female	116	121	
Age	48.06 (10.46)	48.2 (10.73)	8.95E-01
BMI	30.87 (8.02)	31.31 (8.24)	5.91E-01
Health Record Data			
Mean EHR length in days	4076.66 (1902.27)	3829.26 (1843.80)	3.12E-01
Mean number of ER visits	12.64 (32.98)	4.49 (6.15)	6.75E-03
Mean daily MME	51.73 (35.22)	35.77 (19.01)	9.95E-02

ICD-10 EHR Diagnoses for Chart Review Sample of PDMP and Control Patients

	PDMP		Control		p-value
Description	**Distinct patient**	**% of pt's**	**Distinct patient**	**% of pt's**	
Total	**200**		**200**		
Depression	**82**	41%	**33**	17%	1.14E-07
Anxiety disorder	**92**	46%	**39**	20%	3.02E-08
Depression & Anxiety disorder	**52**	26%	**15**	8%	1.43E-06
Total	**200**		**200**		
Alcohol	**7**	4%	**3**	2%	3.37E-01
Nicotine	**85**	43%	**53**	27%	1.11E-03
Opioid	**6**	3%	**0**	0%	3.97E-02
Other Substance Abuse	**9**	5%	**1**	1%	2.50E-02

ICD10 Opioid Use Disorder

- Tolerance (not counted if medication is prescribed by MD)
- Withdrawal (ditto)
- More use of opioids than intended
- Craving for opioids
- Unsuccessful efforts to cut down
- Spends excessive time in acquisition
- Activities given up because of use
- Uses despite negative effects
- Failure to fulfill major role obligations
- Recurrent use in hazardous situations (eg, while driving)
- Continued use despite social or interpersonal problems

Severity judged by numbers of symptoms:

2-3 mild,

4-6 moderate,

7-11 severe

EHR Search Methodology for DSM-V OUD Symptoms

EHR Search Category	DSM-5 Criteria for OUD								
	1	2	3	4	5	6	7	8	9
Vocational Interference Due to Drug Use or Pain					X		X		X
Disabled?					X	X	X		
Was Weaning Described as Unsuccessful or Difficult		X							
Positive Tox Screen for Opioids other than Prescribed	X	X	X	X					X
Lost Pills	X		X						
Multiple Opioid Prescribers	X		X						
Multiple Pharmacies	X		X						
Early Prescription Refills	X	X							
Opioid Overdose								X	X
Substance Abuse	X								X
Hazardous Situation as Result of Opioid								X	
Interpersonal or Legal Issues as Result of Opioid					X	X	X		
Medical Issues as Result of Opioid					X				X
Craving		X		X					
Provider Mentioned Drug-seeking behavior	X	X	X	X					X

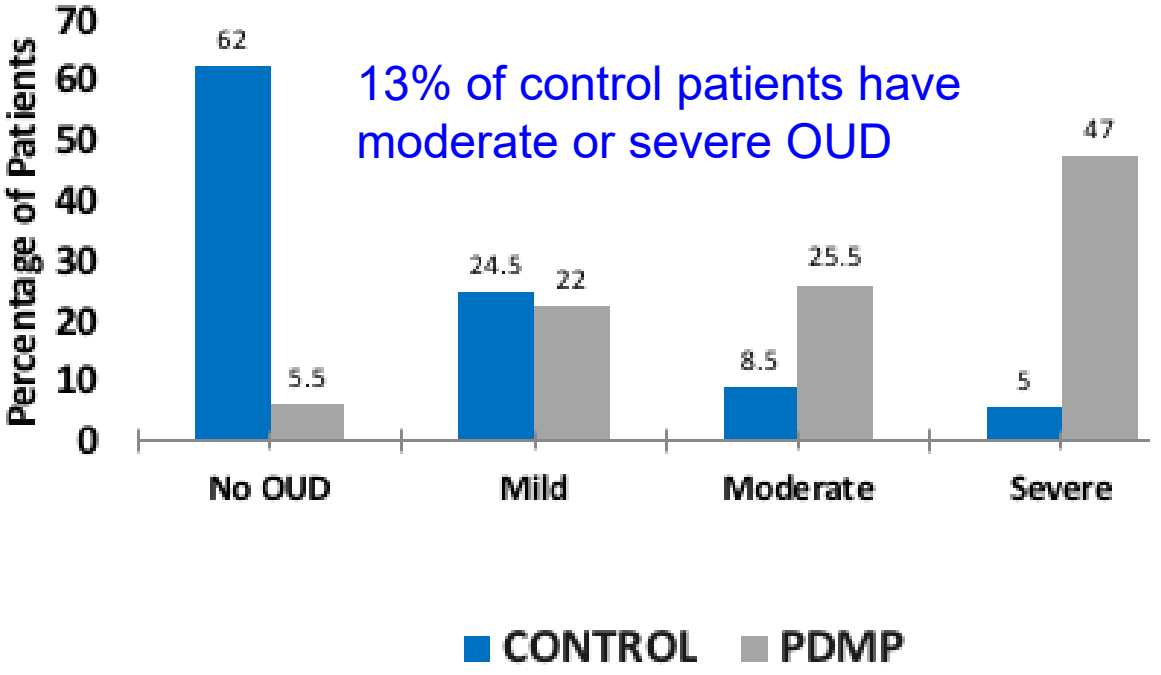
*DSM-5 Criteria defined as 1. More/Longer Use of Opioids than Intended, 2. Unsuccessful Efforts to Cut Down, 3. Time Taken to Obtain or Recover, 4. Craving, 5. Work/School Impact, 6. Interpersonal Impact, 7. Reduced Activities Because of Use, 8. Continued Use When Physically Hazardous, and 9. Use Despite Physical/Psychological Problems

Demographics & OUD Symptoms in 200 Patients Treated Chronically with Opioids for Non-progressive Pain

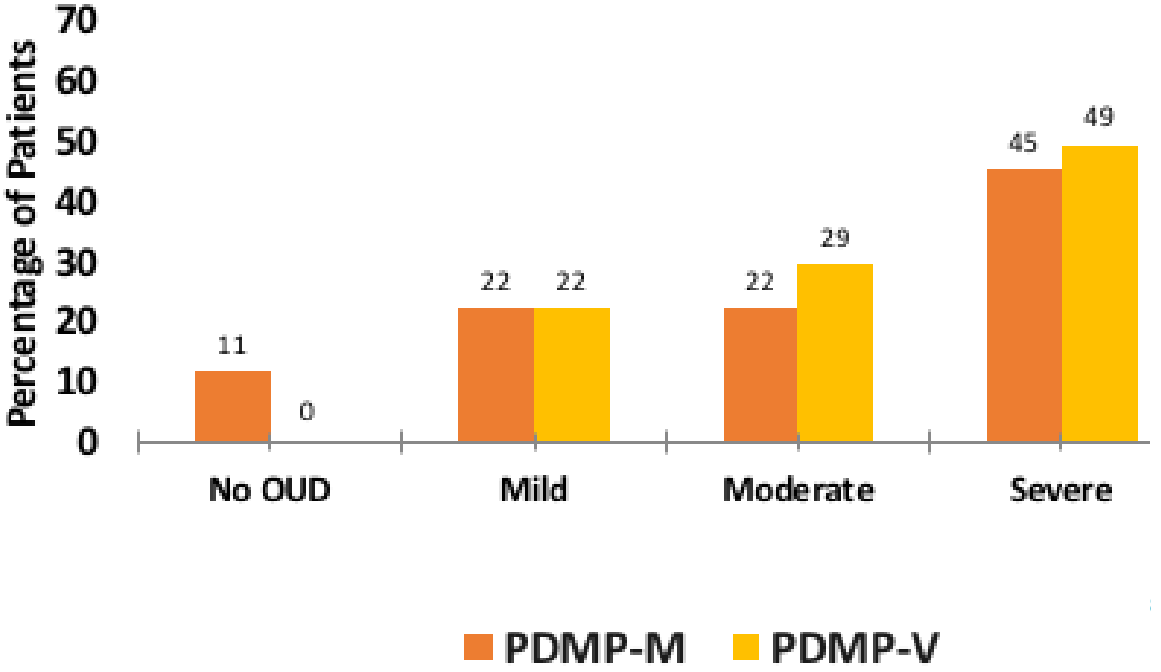
Sample Demographics	Count
N	200
Male	84 (42%)
Female	116 (58%)
ICD: Depression *	69 (35%)
ICD: Anxiety Disorder *	67 (34%)
ICD: Alcohol Use Disorder	14 (7%)
ICD: Tobacco Use Disorder *	133 (67%)
ICD: Opioid Use Disorder	23 (12%)
ICD: Any Substance Use Disorders	141 (71%)
Average Length of Time with MUA	761 days
Average BMI	31.15
Average Recorded Prescription Dose MME (morphine mg equiv)	46.44

DSM-5 Criteria Met	Count
1. More/Longer Use	161 (81%)
2. Unsuccessful Weaning	144 (72%)
3. Time Taken to Obtain/Recover	106 (53%)
4. Craving	56 (28%)
5. Work/School Impact	146 (73%)
6. Interpersonal Impact	113 (57%)
7. Reduced Activities Due to Use	120 (60%)
8. Continued Use When Hazard	48 (24%)
9. Use with Physical/Psych. Problems	145 (73%)
10. Tolerance	158 (79%)
11. Withdrawal	23 (12%)

Rates of DSM-V OUD Dx by chart review in the control (n=200), PDMP (n=200) patients.



Rates of DSM-V OUD Dx by chart review in the PDMP-M (n=100) and PDMP-V (n=100) patients.



Demographics for Entire Sample of PDMP and Control Patients

	PDMP	Control	p-value
Sample Demographics			
N	16,253	16,253	
Male	6,944	6,949	9.28E-01
Female	9,309	9,304	
Age	51.88 (13.7)	50 (14.65)	6.24E-33
BMI	31.69 (8.4)	31.45 (8.37)	9.63E-03
Health Record Data			
Mean EHR length in days	4211 (2073.76)	2650 (2352.2)	<E-200
Mean number of ER visits	8.552 (15.99)	3.57 (5.14)	3.58E-184
Mean daily MME	51.74 (78.2)	44.32 (71.8)	5.32E-20

EHR Diagnoses for Entire Sample of PDMP and Control Patients

Description	Distinct patient	% of pt's	Distinct patient	% of pt's	p-value
Total	**16253**		**16253**		
Depression	5446	33.51%	1473	9.06%	0.00E+00
Anxiety disorder	6552	40.31%	1605	9.88%	0.00E+00
Alcohol	489	3.01%	137	0.83%	1.49E-45
Nicotine	4760	29.29%	1523	9.26%	0.00E+00
Opioid	291	1.79%	48	0.29%	7.41E-40
Other Substance Abuse	570	3.51%	106	0.64%	2.10E-72

Genetic Analysis of Opioid Dose

- **Genotypes---GWAS array genotypes for common alleles**
- **• Whole exome sequencing (WES) / Imputed (1000 Genomes)**
- **• Phenotypes**
- • Opioid prescription dosage from EHR medication records, years 2012-17
  - ≥ 90 days of opioid prescribed; 90 days max gap among prescriptions (90-90 Rule)
  - Final regular dose: Morphine milligram equivalents (MME)
  - Excluded patients with ICD codes for metastatic cancer and hospice
  - Vast majority of patients had non-progressive musculo-skeletal pain.
  - 97% of patients had European-American ancestry by DNA analysis.
- **• Any opioid (oxycodone, tramadol, hydrocodone most common).**
- **Covariates**
- • Sex, Age, Age^2, Principle Components 1-4 from population substructure analysis
- **Association Tests:**
- **• Mixed Linear Model Association analysis by GCTA + FASTBAT**
  - **Discovery set : First 90,000 Geisinger patients with WES**
  - **Replication:** Next 60,000 Geisinger patients, Million Veteran Program

Demographics Of Chronic Opioid Use Patients

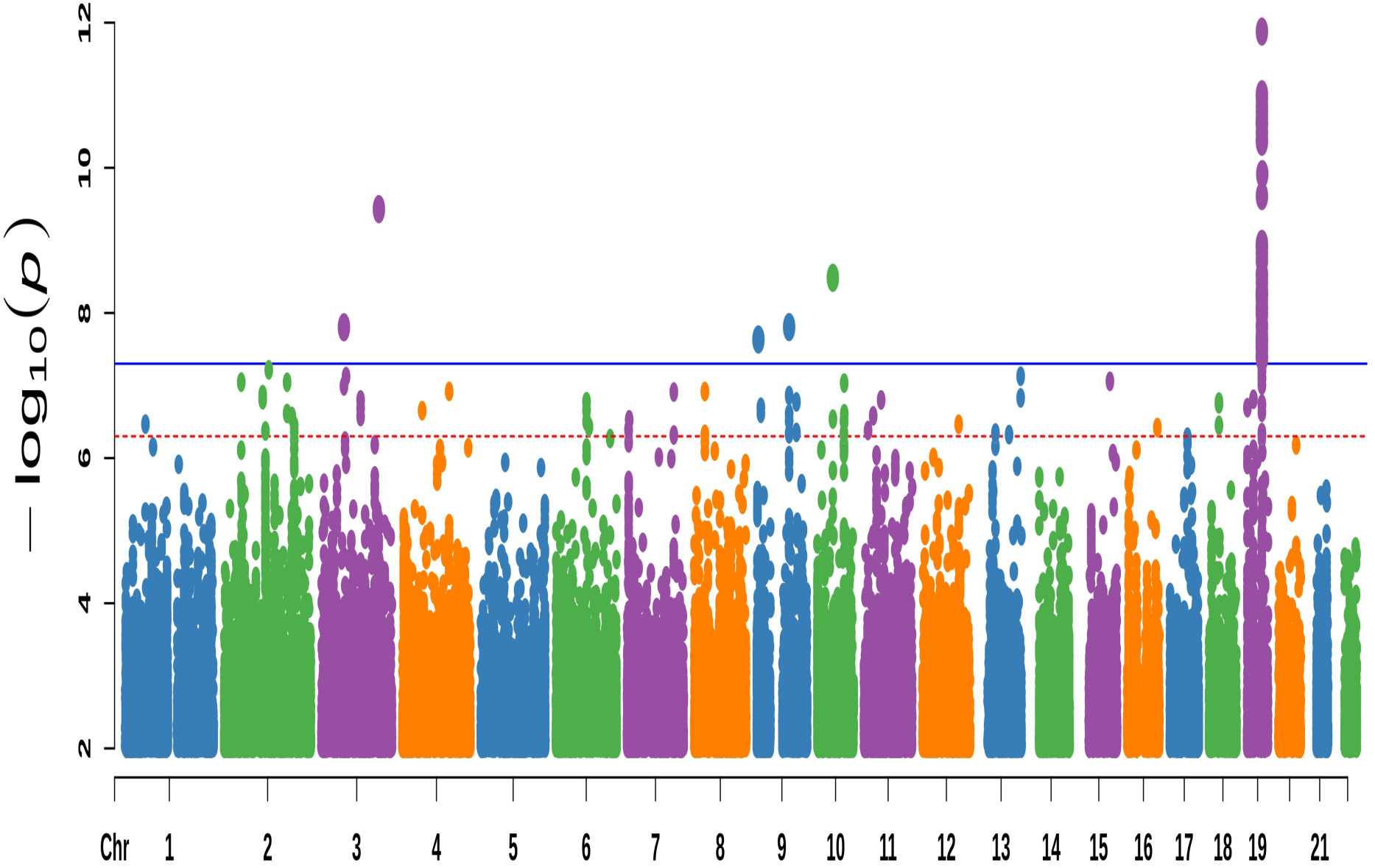
	Sex	n	min	median	max	mean	sd	q25	q75
Age	F	4502	18	59	89	58.3	14.9	48	69
	M	2468	21	61	89	60	13.4	52	69
BMI	F	4501	17.7	31.8	79.3	32.8	8.66	26.5	37.7
	M	2467	17.8	31.2	72.4	32.3	7.78	27.1	36.2
Smoker	F	2936							
	M	1902							
Deceased	F	37							
	M	39							

Self-identified Ancestral Origin (unknown = 3)	Asian	African	European	Nat. American	Pacific Islands
	9	152	6783	19	4

Analysis restricted to European ancestral origin (defined by genomic analysis) patients with non-progressive musculo-skeletal pain. Patient population is older, mostly women, with a substantial degree of obesity.

GWAS of Imputed Genotype and Final Opioid Dose Values

N=6406 European-American samples. Co-variates are sex, age, age^2, BMI



GWAS Analysis On Final Dosage Values – Top Hits

SNP	A1	A2	Freq	Beta	SE	Pvalue	Z-score	GENE	Distance
19:41502591	C	T	0.009528	**31.7671**	4.4796	**1.33E-12**	7.0915	**CYP2B6**	0
19:41516446	T	G	0.010091	**29.2021**	4.35853	**2.08E-11**	6.69999	**CYP2B6**	0
19:41497129	C	T	0.009916	**29.3249**	4.39189	**2.44E-11**	6.67706	**CYP2B6**	74
19:42508415	C	A	0.006765	**36.9559**	5.74168	**1.22E-10**	6.43643	**GRIK5**	0
3:160872546	A	G	0.022316	**19.3055**	3.08107	**3.71E-10**	6.26584	**NMD3**	0
19:41483146	T	C	0.00893	**28.3456**	4.65317	**1.12E-09**	6.09168	**CYP2B6**	14057
10:43311788	G	A	0.004959	**37.3482**	6.31193	**3.28E-09**	5.91708	**BMS1**	0
19:41490220	G	T	0.008992	**27.1035**	4.633	**4.91E-09**	5.8501	**CYP2B6**	6983
19:41494747	A	G	0.009355	**25.9567**	4.53527	**1.04E-08**	5.7233	**CYP2B6**	2456
19:41493721	G	C	0.009404	**25.5391**	4.51653	**1.56E-08**	5.65458	**CYP2B6**	3482
9:4861936	T	A	0.010412	**24.1727**	4.3272	**2.32E-08**	5.58622	**RCL1**	0
19:41493931	A	G	0.009486	**25.1104**	4.49805	**2.37E-08**	5.58251	**CYP2B6**	3272
13:112178960	A	G	0.00759	**27.2639**	5.06748	7.44E-08	5.38017	**RP11-65D24.2**	61587
3:69079256	T	C	0.010249	**23.6531**	4.39786	7.52E-08	5.37832	**TMF1**	0
2:47780973	T	C	0.004623	**34.5617**	6.46509	9.00E-08	5.3459	**KCNK12**	0
2:47780973	T	C	0.004623	**34.5617**	6.46509	9.00E-08	5.3459	**MSH2**	0
2:176006253	T	C	0.004147	**36.8373**	6.89106	9.01E-08	5.34567	**ATF2**	0
10:75042138	C	A	0.003961	**37.1672**	6.95908	9.25E-08	5.34082	**TTC18**	0
19:41519939	G	A	0.01018	**23.1392**	4.34228	9.89E-08	5.32881	**CYP2B6**	0

FASTBAT (Bakshi et al, Sci Rep, 2016)

Nearly all human genes possess a wide array of common and rare variants.

It is often the case that more than one variant in a gene increases risk for a phenotype.

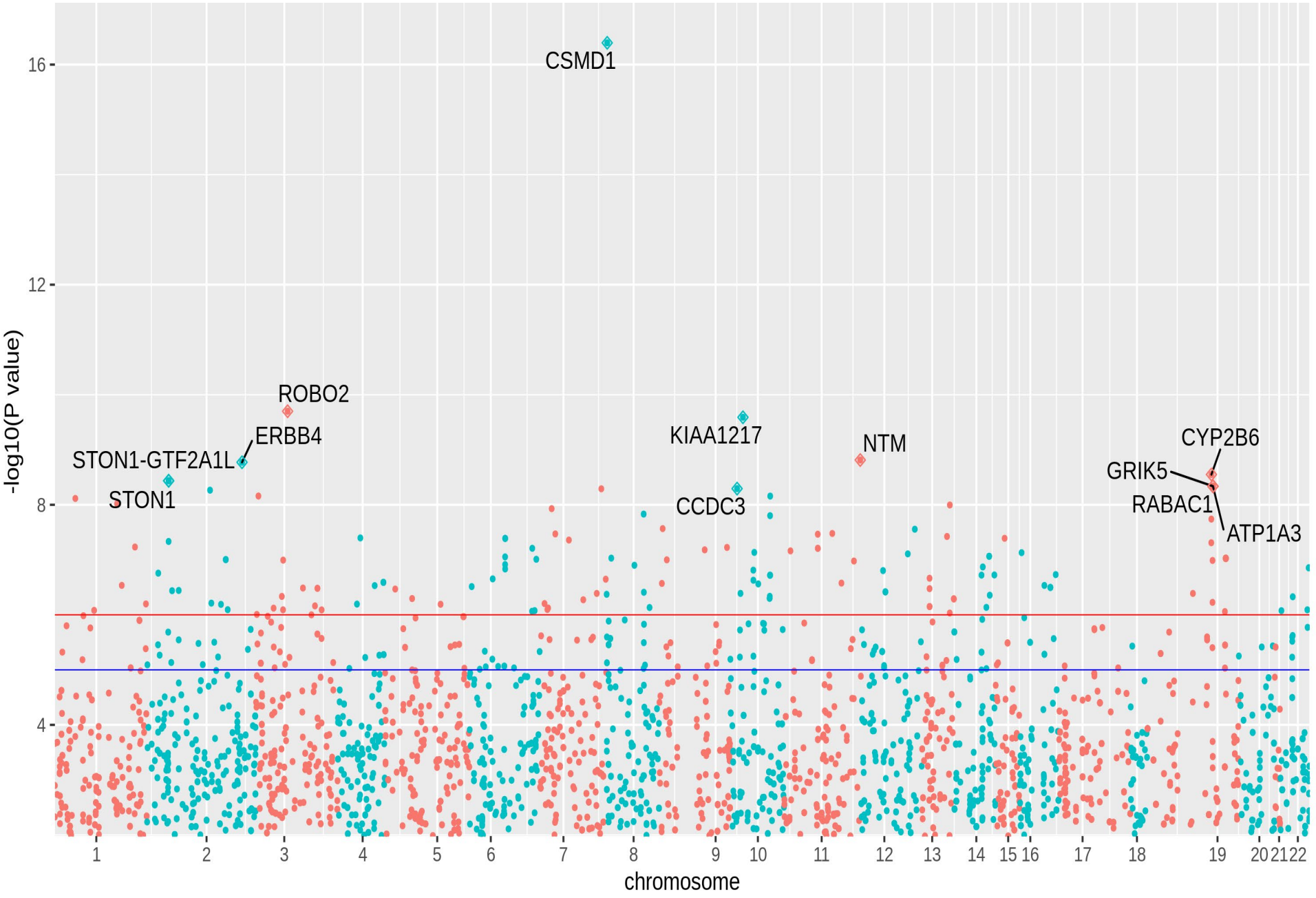
However, many analytic approaches test one variant at a time.

FASTBAT uses the "gene as the unit of analysis" approach, removing variants in high linkage disequilibrium with the index allele.

FASTBAT then assesses evidence for association across a pre-specified region (eg, 50kb from the 5' & 3' UTRs of a gene).

FASTBAT has a smaller multiple testing correction than GWAS.

Gene-based FastBAT Analysis: Manhattan Plot



Gene-based FastBAT Analysis – Top Hits

Gene	Chr	Start	End	# SNPs	χ^2 (Obs)	P value	Top SNP P value	Top SNP
CSMD1	8	2742874	4902328	14	114.792	4.02E-17	0.00060158	8:3930773
ROBO2	3	77039293	77749114	8	81.8543	1.99E-10	2.69E-05	3:77502696
KIAA1217	10	23933674	24886777	7	59.0098	2.57E-10	0.00071350	10:24696221
NTM	11	1.31E+08	1.32E+08	5	49.8785	1.54E-09	3.73E-05	11:132252245
ERBB4	2	2.12E+08	2.13E+08	11	106.941	1.69E-09	2.46E-06	2:213442335
CYP2B6	19	41447203	41574301	7	211.988	2.81E-09	2.45E-10	19:41527829
STON1	2	48707307	48875654	5	48.0196	3.66E-09	0.00031586	2:48723124
STON1-GTF2A1L	2	48707063	49053656	5	48.0196	3.66E-09	0.00031586	2:48723124
ATP1A3	19	42420733	42548428	2	65.7162	4.60E-09	1.22E-10	19:42508415
GRIK5	19	42452467	42619957	2	65.7162	4.60E-09	1.22E-10	19:42508415
RABAC1	19	42410832	42513528	2	65.7162	4.60E-09	1.22E-10	19:42508415
CCDC3	10	12888624	13191773	2	38.2889	5.08E-09	3.81E-06	10:13071690
CNTNAP2	7	1.46E+08	1.48E+08	11	108.939	5.12E-09	3.35E-05	7:146270310
LRP1B	2	1.41E+08	1.43E+08	9	99.6958	5.43E-09	6.11E-05	2:141429140
GRM7	3	6852801	7833218	9	101.038	6.93E-09	4.44E-06	3:7138303
USP54	10	75207295	75385433	2	37.6622	6.95E-09	2.45E-07	10:75316958
DAB1	1	57413578	58766211	6	72.748	7.67E-09	3.40E-07	1:57852859
BLZF1	1	1.69E+08	1.69E+08	2	37.0416	9.54E-09	1.31E-05	1:169337581
CCDC181	1	1.69E+08	1.69E+08	2	37.0416	9.54E-09	1.31E-05	1:169337581
NME7	1	1.69E+08	1.69E+08	2	37.0416	9.54E-09	1.31E-05	1:169337581
PTPRD	9	8264245	10662723	9	79.3552	2.71E-08	8.66E-05	9:9870817

PTPRD: Protein Tyrosine Phosphatase Receptor, delta (tumor suppressor gene)

Ward J et al: Genome-wide analysis in UK Biobank identifies four loci associated with mood instability and genetic correlation with major depressive disorder, anxiety disorder and schizophrenia. Transl Psychiatry. 2017 7:1264

PTPRD alleles associated with mood instability. Phenotype is answer to the question: *'Does your mood often go up and down?'*
53,525 cases of mood instability and 60,443 controls.
rs10959826 in PTPRD on chr 9 G/A SNP P = 7.7×10^{-9}

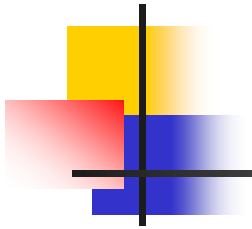
CSMD1: cub and sushi multiple domains 1 (tumor suppressor gene) common alleles are GWAS-significant in schizophrenia

Rare mutations cause familial Parkinson's Disease

All Opioids: CSMD1 & PTPRD Statistics

Gene	# SNPs	1st SNP*	Last SNP*	χ^2	P	Top SNP*	P
CSMD1	14	8:3121439	8:4706207	115	$4e^{-17}$	8:3930773	$6e^{-4}$
PTPRD	9	9:9200806	9:10554882	79	$3e^{-8}$	9:9870817	$9e^{-5}$

*Hg19/GRCH37



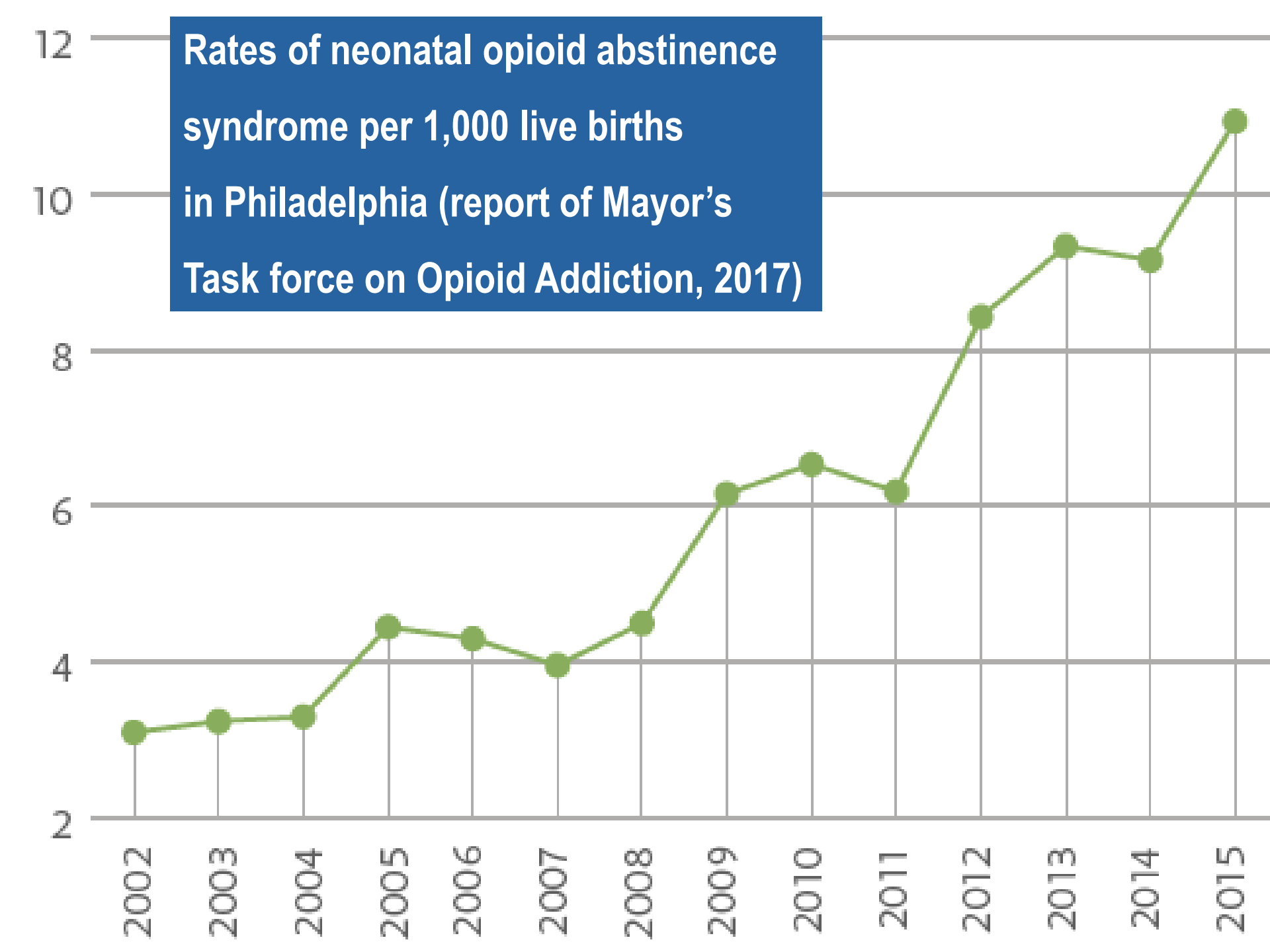
- **The opioid crisis is trans-generational.**

Table 1: NOWS Clinical Signs

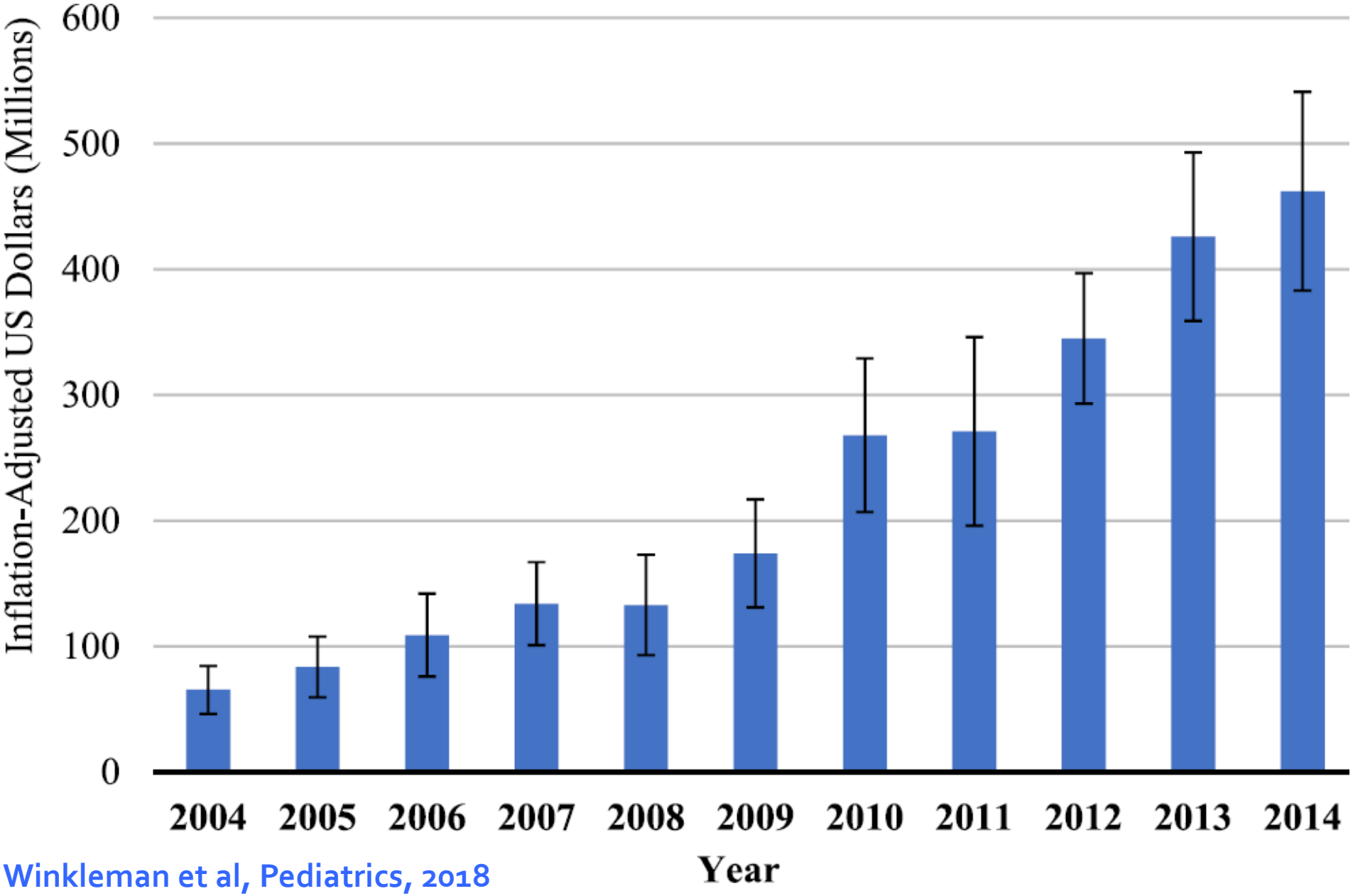
NOWS emerges 12-72 hours after birth in 55-95% of infants whose mothers are taking opioids on a daily basis during pregnancy.

Common signs:

- high-pitched cry
- exaggerated reflexes
- tremors
- loose stools
- ineffective sucking
- sweating
- sneezing
- inconsolable crying
- irritability
- hypertonicity
- vomiting
- poor feeding
- failure to thrive
- temperature instability,
- nasal congestion
- fever


Rates of neonatal opioid abstinence syndrome per 1,000 live births in Philadelphia (report of Mayor's Task force on Opioid Addiction, 2017)
12
10
8
6
4
2
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

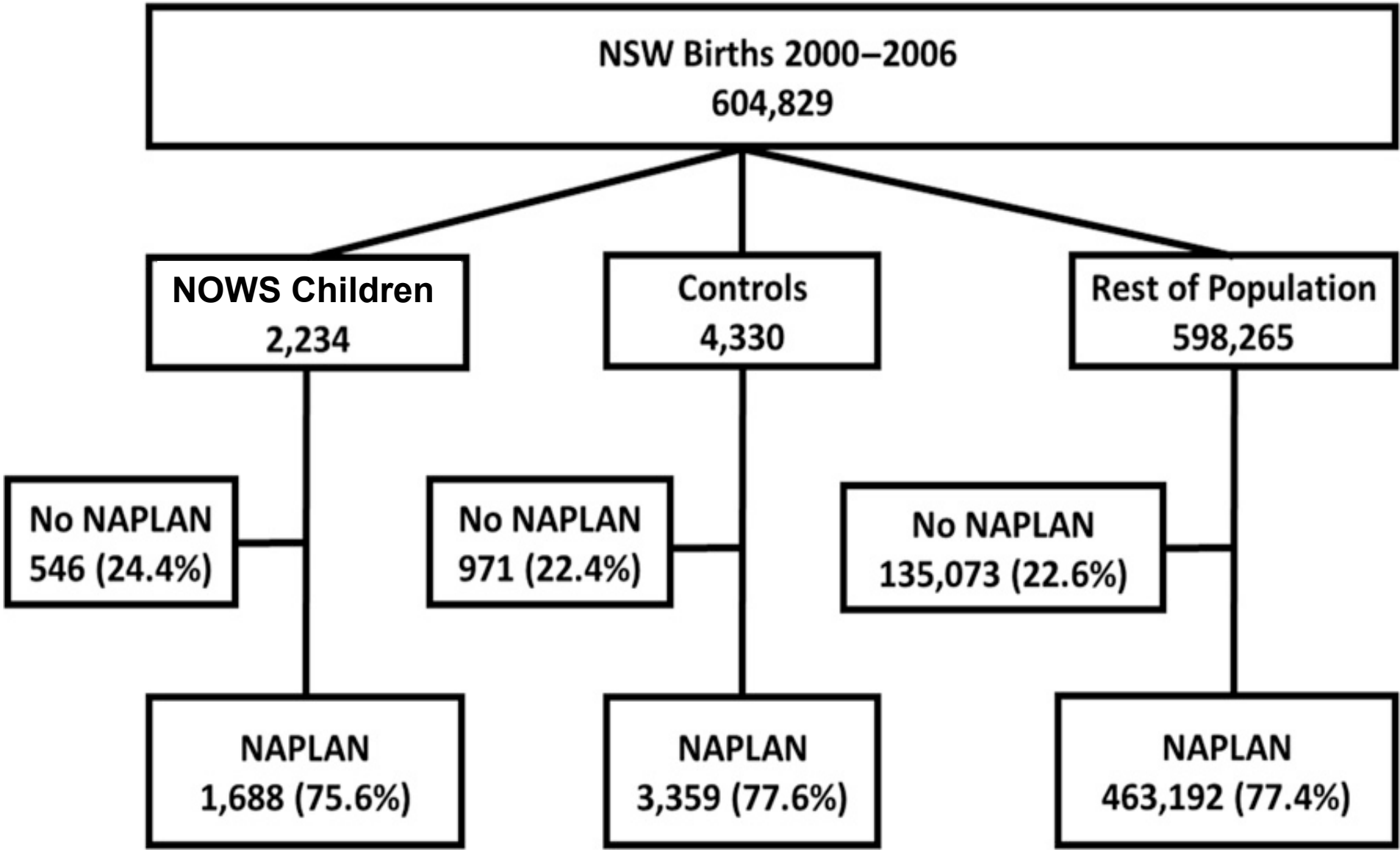
Medicaid Hospital Costs for NOWS Neonates



Winkleman et al, Pediatrics, 2018

Australian Study of Cognition in NOWS Children at Ages 9, 11 and 13
Oei et al, Pediatrics, 2017

NAPLAN is a national standardized test of reading, math, spelling, grammar. Controls were children matched for NOWS group demographics, socioeconomic status, etc.



Australian NOWS Neonates & Control Neonates

*P<0.05; **P<0.01	NOWS n = 2234	Control n = 4330	NOWS vs Control
			Oei et al, Pediatrics, 2017
Mother			
Maternal age, y	28.4 (5.7)	29.6 (5.8)	$P<.001$
Previous pregnancies	1.7 (1.6)	1.1 (1.3)	$P<.001$
Indigenous	336 (15.0%)	164 (3.8%)	3.9 (3.3–4.7)*
<< No antenatal care >>	318 (14.2%)	202 (4.7%)	3.4 (2.8–4.1)**
Tertiary hospital birth	1148 (51.3%)	1251 (28.9%)	2.6 (2.3–2.8)**
Rural residence	320 (14.3%)	732 (16.9%)	1.0 (0.9–1.2)**
Cesarean delivery	504 (22.5%)	1333 (30.8%)	0.6 (0.5–0.07)*
Infant			
5-min Apgar	8.8 (0.9)	8.9 (1.1)	$P<.001$
Gestation, wk	37.9 (2.4)	37.9 (2.4)	$P=.78$
<< Birth wt, g[a] >>	2852 (580)	3147 (682)	$P<.001$
Male	1175 (52.5%)	2303 (53.2%)	0.9 (0.8–1.1)
<< Nursery admission >>	1705 (76.3%)	1232 (28.4%)	8.1 (7.2–9.1)*

% 8 yo Children Failing to Meet Minimum National Standards

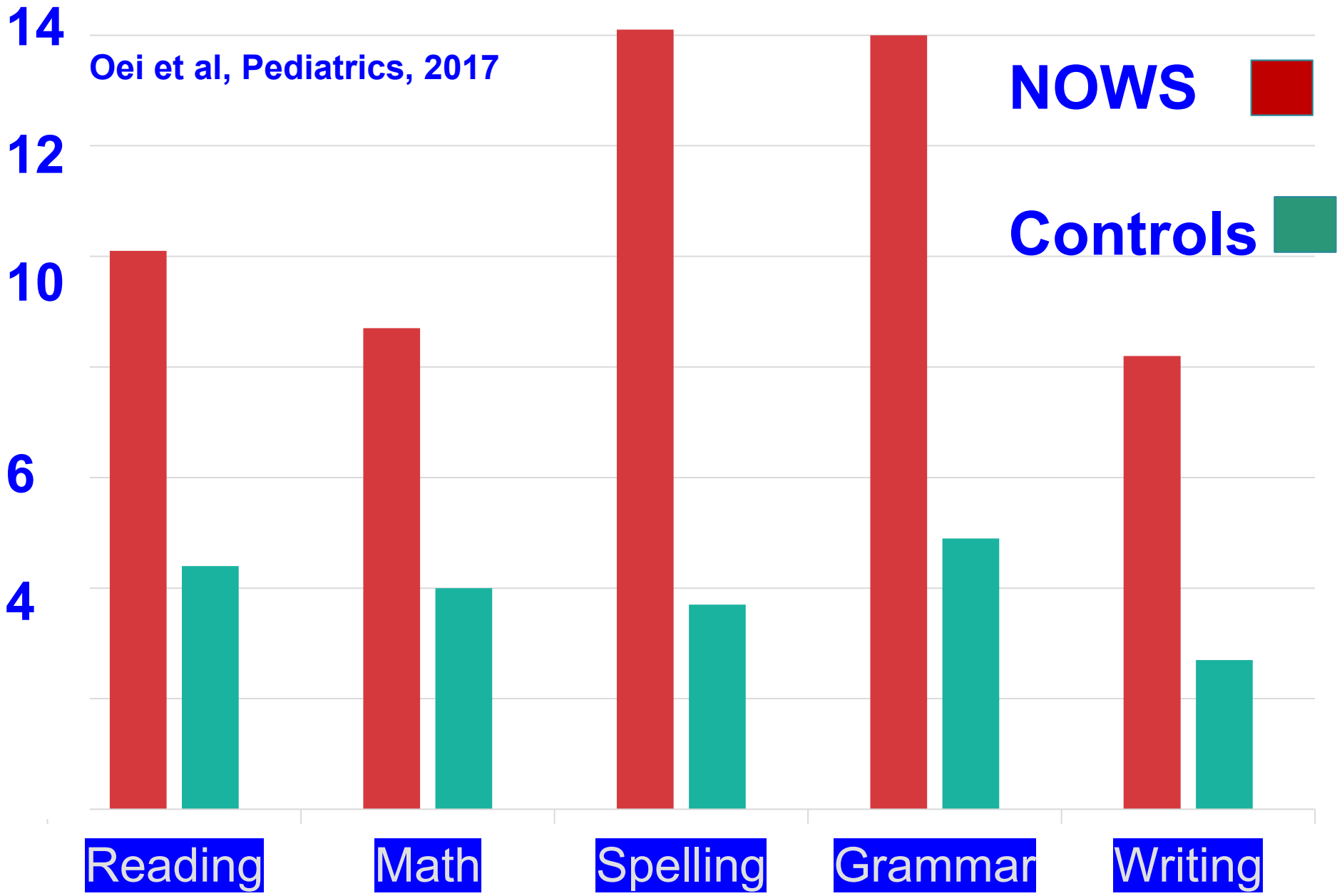
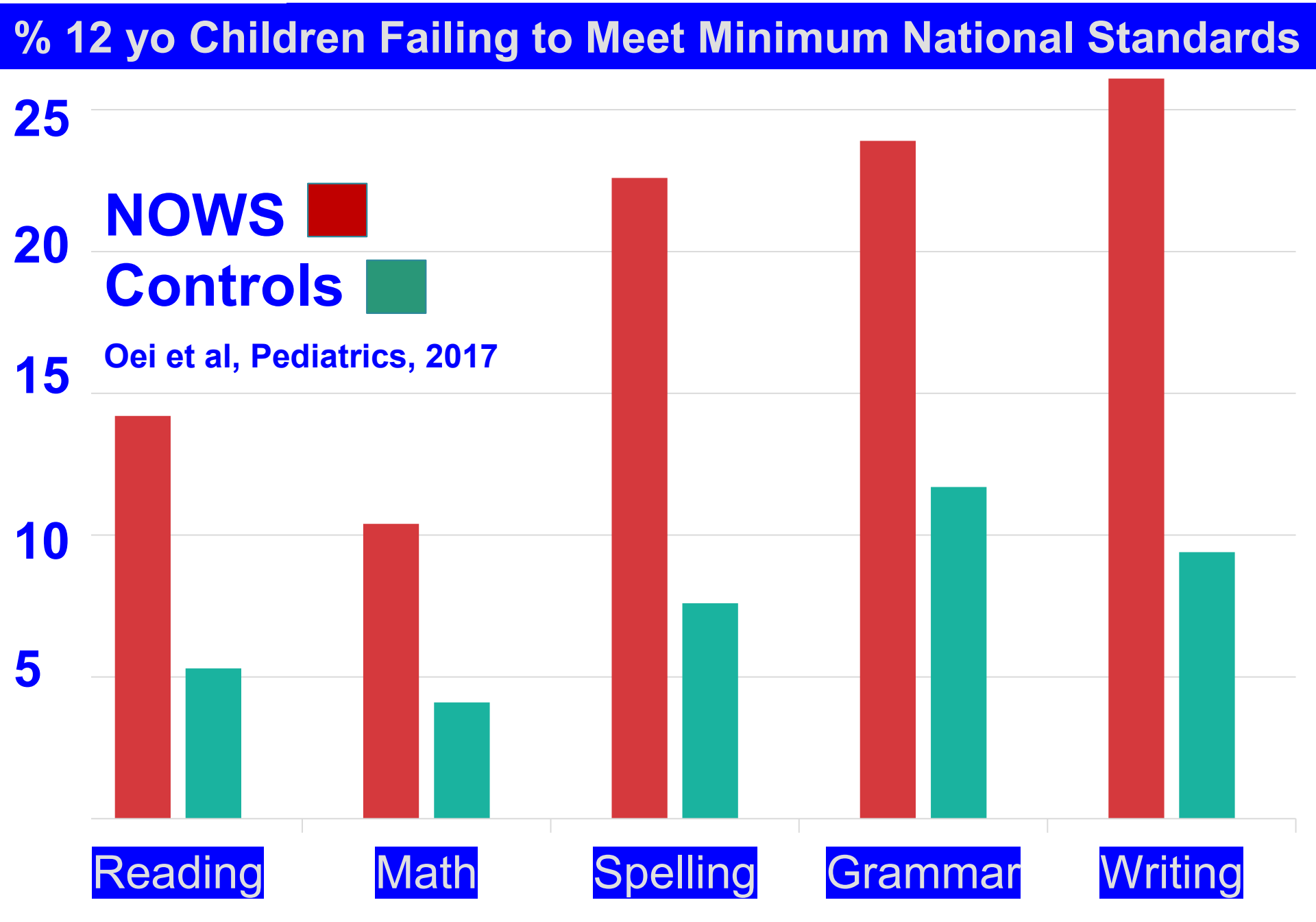


Figure 2


% 12 yo Children Failing to Meet Minimum National Standards
25
20
15
10
5
NOWS
Controls
Oei et al, Pediatrics, 2017
Reading
Math
Spelling
Grammar
Writing

NOWS EHR Analyses by Raghu Metpally, PhD

In the years 2011-17, 969 babies born at Geisinger were assigned ICD-10 code P96.1, neonatal withdrawal symptoms from maternal use of drugs of addiction.

526 of these patients were seen in the past 2 years at Geisinger.

Very little is known about the developmental, behavioral and cognitive challenges these individuals encounter as they develop through childhood and adolescence.

We wish to access de-identified records of these Geisinger P96.1 patients and their mothers to determine the types of Geisinger appointments, procedures and ICD-10 codes that characterize these patients.

We have a longer-term goal to contact these Geisinger P96.1 patients and their mothers to request their consent to assess them for behavioral, cognitive and developmental characteristics.

ICD10 Codes for Mothers of NOWS Babies at Geisinger (526 infants born to 473 mothers, 11/2007-4/2019)

ICD10	ICD10_DESCRIPTION	Count 1 call	% 1 call
O09.899	Supervision of other high-risk pregnancies, unspecified trimester	392	82.9
Z23	Encounter for immunization	327	69.1
F11.20	Opioid dependence, uncomplicated	316	66.85
O99.320	Drug use complicating pregnancy, unspecified trimester	305	64.5
Z72.0	Tobacco use	287	60.7
Z34.80	Encounter for supervision of other normal pregnancy, unspecified trimester	264	55.8
F17.200	Nicotine dependence, unspecified, uncomplicated	260	55.0
O99.330	Smoking (tobacco) complicating pregnancy, unspecified trimester	241	51.0
O09.90	Supervision of high-risk pregnancy, unspecified, unspecified trimester	234	49.5
Z01.419	Encounter for gynecological examination (general) (routine) without abnormal findings	222	46.9
F32.9	Major depressive disorder, single episode, unspecified	221	46.7

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
1	7	16	29	29	33	52	61	60	72	63	73	30	526

ICD10 codes for NOWS Infants at Geisinger, 11/2007-4/2019 (526 infants born to 473 mothers)

ICD10	ICD10_DESCRIPTION	count_1call	%_1call
P96.1	Neonatal withdrawal symptoms from maternal use of drugs of addiction	526	100
J06.9	Acute upper respiratory infection, unspecified	258	49.05
B97.89	Other viral agents as the cause of diseases classified elsewhere	215	40.87
L22	Diaper dermatitis	175	33.27
P00.2	Newborn affected by maternal infectious and parasitic diseases	170	32.32
R05	Cough	123	23.38
O98.419	Viral hepatitis complicating pregnancy, unspecified trimester	115	21.86
R50.9	Fever, unspecified	115	21.86
P00.9	Newborn affected by unspecified maternal condition	112	21.29
N47.8	Other disorders of prepuce	111	21.10
O99.320	Drug use complicating pregnancy, unspecified trimester	107	20.34
P59.9	Neonatal jaundice, unspecified	102	19.39
B18.2	Chronic viral hepatitis C	98	18.63

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
1	7	16	29	29	33	52	61	60	72	63	73	30	526

Analyses by Karena Moran, PhD (NEPaPQC), of EHR Records, 1/2016 to 9/2018:

672 pregnant women with OUD were identified by ICD-10 codes F11.20, O99.320 and Z79.891, totaling 5% of all infant born at Geisinger in these 30 months!

14% of pregnant OUD women received medication-assisted treatment during pregnancy.

45% of delivered OUD women kept the postpartum appointment, compared to 72% of women without OUD.

SUMMARY

Risk for OUD is unacceptably high when opioids are prescribed chronically for non-progressive musculo-skeletal pain. In our control chart review sample (n=200) 13% of patients had moderate or severe OUD, but none of these had an EHR OUD diagnosis.

Primary care physicians do not often diagnose OUD in their pain patients who are being treated with opioids over an extended period of time.

We must improve efforts to engage pregnant women with OUD in medication-assisted treatment.

NOWS children have progressive cognitive deficits which our school systems are ill-equipped to address.

Acknowledgements

University of Pennsylvania
Rick Crist, PhD
Glenn Doyle, PhD
Mingyao Li, PhD

Rowan University Cooper School of Medicine
Thomas N. Ferraro, PhD

Florida Atlantic University
Janet Robishaw, PhD
Sarah Palumbo

Geisinger
Vanessa Troiani, PhD
Raghu Metpally, PhD
Kayleigh Adamson
Sarah Robishaw
SarathBabu Krishnamurthy, PhD
David J Carey, PhD
Sarah Pendergrass, PhD
Joseph Chronowski, PhD
Karena Moran, PhD

Funding: Commonwealth of Pennsylvania Department of Health CURE grant (WHB)
K01 DA036751 (RC)
R01 DA044015 (VT, WHB & JR)