Toxicology Topics: Drug Levels for Buprenorphine: Efficacy, Diversion, and Compliance.

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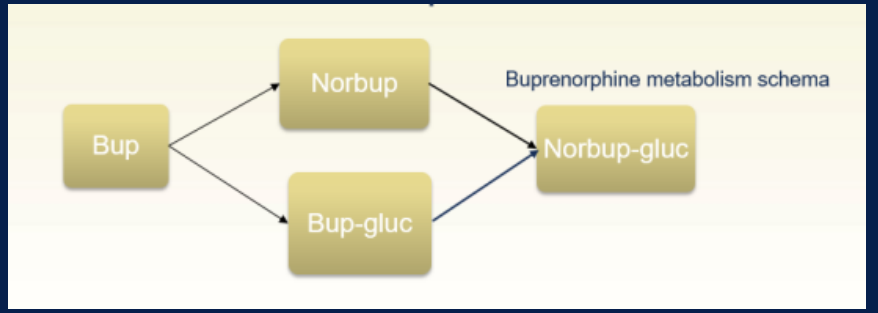

ASAM 53rd Annual Conference

#ASAMAnnual2022

Disclosure Information

Toxicology Topics: Drug Levels for Buprenorphine: Efficacy, Diversion, and Compliance.

April 3rd, 2022 from 11:00 AM – 12:00 AM

Timothy J. Wiegand, MD, FACMT, FAACT, DFASAM

- No Financial Disclosure

Toxicology Topics: Drug Levels for Buprenorphine: Efficacy, Diversion, and Compliance.

April 3, 2022 from 11:00 – 12:00

Hiroko Furo, MD, Ph.D., MA, MS, MSES

- No Financial Disclosure

Toxicology Topics: Drug Levels for Buprenorphine: Efficacy, Diversion, and Compliance.

April 3, 2022 from 11:00 – 12:00

JoAn Laes, MD, FASAM

- No Financial Disclosure

Toxicology Topics: Drug Levels for Buprenorphine: Efficacy, Diversion, and Compliance.

April 3, 2022 from 11:00 to 12:00

Soumya Pandalai, MD, FACP, FASAM

- No Financial Disclosure

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Learning Objectives

At the conclusion of this activity, attendees will be able to:

- Describe the different types of oral and urine testing profiles available for buprenorphine including utility, accuracy, cost and limitations for each test and administration modality (e.g., remote oral testing).
- Identify the aspects of the pharmacodynamics and pharmacokinetics of buprenorphine, metabolites, and naloxone and how they relate to quantitative laboratory analysis.
- Describe the use of buprenorphine testing in clinical addiction medicine, focusing on different methods of interpretation including the use of buprenorphine and metabolite levels, use of creatinine normalized metabolite levels, and use of metabolite ratios to guide clinical management of patients receiving buprenorphine for opioid use disorder.

Audience Polls

go to: PollEv.com/robertcolepueringer579

— or —

text: ROBERTCOLEPUERINGER579
to 37607

In what ways do you use buprenorphine testing in your practice?

Only urine qualitative (immunoassay)

Urine qualitative and confirmation testing (metabolite levels)

Urine qualitative, confirmation (metabolite levels) and oral screens

I don’t use buprenorphine testing

Audience Poll

In what ways do you use buprenorphine testing in your practice?

- A.) Only urine qualitative (immunoassay).
- B.) Urine qualitative and confirmation testing (metabolite levels)
- C.) Urine qualitative, confirmation (metabolite levels) and oral screens.
- D.) I don’t use buprenorphine testing

How comfortable are you in applying and interpreting buprenorphine testing in your practice?

Novice (Not at all comfortable)

Beginner (Aware they are available and just learning how to apply)

Intermediate (I can apply basic principles to testing (e.g., understand specimen validity testing, how to tell adulteration and basics about metabolite levels)

Expert (I routinely interpret levels and understand nuances about each type of test and testing modality and can apply my knowledge to patient care)

Audience Poll

How comfortable are you in applying and interpreting buprenorphine testing in your practice?

- A.) Novice (Not at all comfortable)
- B.) Beginner (Aware they are available and just learning how to apply)
- C.) Intermediate (I can apply basic principles to testing (e.g., understand specimen validity testing, how to tell adulteration and basics about metabolite levels)
- D.) Expert (I routinely interpret levels and understand nuances about each type of test and testing modality and can apply my knowledge to patient care).

Interpreting buprenorphine/norbuprenorphine levels

- A patient is reporting craving taking 8/2 mg of buprenorphine/naloxone BID.
- Requests dose increase to 24 mg/day
- Buprenorphine 6 ng/mL, norbuprenorphine 26 ng/mL, Cr 68 mg/dL

DRUG TOX MONITORING BUPRENORPHINE,QUANT,URINE

Result Date: 06/28/19 12:32 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
BUPRENORPHINE QUANT See note #1	6	CUTOFF=2	NG/ML	A
NORBUPRENORPHINE QUANT See note #1	26	CUTOFF=2	NG/ML	A

DRUG TOX MONITORING ETHYL ALCOHOL,W/CONF,URINE

Result Date: 06/28/19 12:32 PM

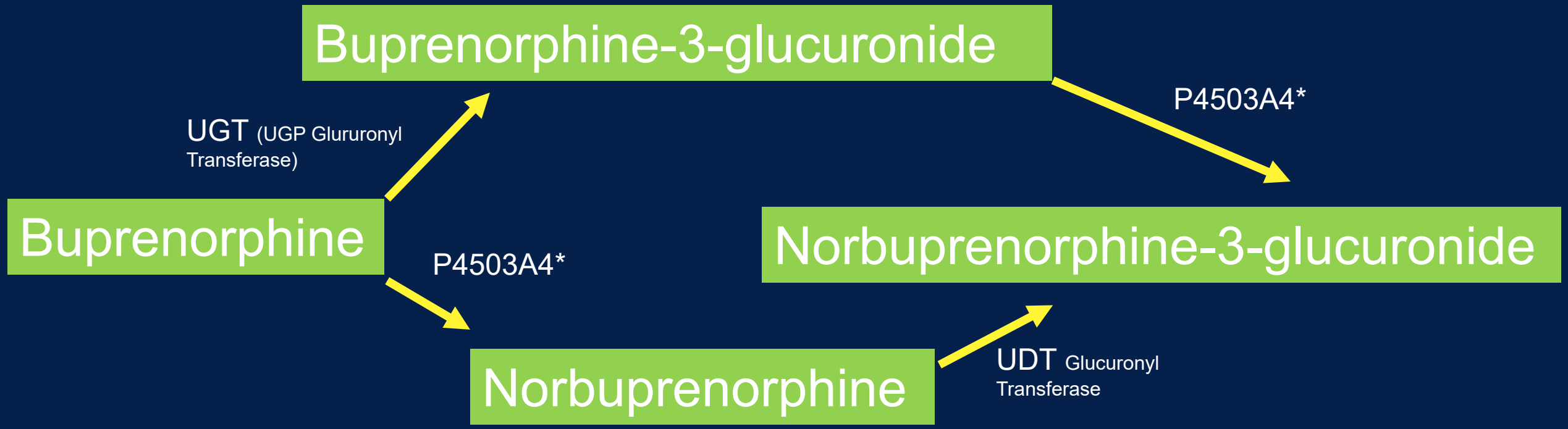
Analyte	Result Value	Ref. Range	Units	Out of Range
ETHANOL SCREEN CUTOFF=20	NEGATIVE	CUTOFF=20	MG/DL	

Background

- Buprenorphine metabolism
- Buprenorphine formulations
- Buprenorphine pharmacology and drug interactions
- Buprenorphine metabolite profile definition and introduction of testing panels

Buprenorphine metabolism
(mainly by P450 3A4 and 2C8)

Other metabolic pathways (minor) also involved.



Hagelberg NM, et al. Rifampicin decreases exposure to sublingual buprenorphine in healthy subjects. Pharmacol Res Perspect. 2016 Dec; 4(6): e00271. PMID: 28097004.

Buprenorphine formulations

- Dual products 4/1 ratio buprenorphine/naloxone
  - 2/0.5, 4/1, 8/2, 12/3 doses
  - Tablets and films
  - Different brands -5.7/1.4 mg, other

Mono product buprenorphine alone 2 mg and 8 mg

Injectable SC buprenorphine (300 mg/month + 100 mg/month)*

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Excerpt from Buprenorphine lecture by Clinical Education Initiative NY State Department of Health and Institute 2021

Buprenorphine Pharmacology

Pharmacokinetics

- Oral (GI) bioavailability varies widely (3-16%)
- SL bioavailability varies widely (30-55%)*
- Peak [buprenorphine] 1-3 hours after SL dose.
- 10-30% excreted renally (mainly metabolites)
  - Urine detection:
    - Buprenorphine 1-7 days
    - Norbuprenorphine 1-14 days
- 70-90% fecal elimination

Drug Interactions

- Mainly P4503A4
- 3A4 inducers → decreased buprenorphine concentration
  - Rifampin*
- 3A4 inhibitors → increased buprenorphine concentration
  - Atazanavir
  - Ritonavir

*McCance-Katz EF, et al. Rifampin, but not rifabutin, may produce opiate withdrawal in buprenorphine-maintained patients. *Drug Alcohol Depend* 2011. 118: 326–334.

Testing is *part* of a comprehensive program

Probation Letter

- Completed treatment
- Continues in clinic
- Regular contact
- Working
- In stable relationship
- Volunteering (*AA, peer Counselor, hospital*)
- Urine screens

Dear Mr. XX:

I am writing this letter for inclusion in any review of Ms. XX related to probation

I have worked with Ms. XX now for 3 years and throughout that time with at least monthly contact. Ms. XX has completed Huther Doyle, an intensive outpatient treatment program. Huther Doyle is certified by the New York State Office of Alcohol and Substance Abuse Services (OASAS). After completion of Huther Doyle she continued to see me through the Strong Memorial Hospital Toxicology clinic. She is prescribed Suboxone™ for her opioid dependence and she has no craving or withdrawal. She has been sober since the start of her treatment program in 2013. In addition to counseling, group, and individual sessions she has been monitored with random urine drug screens as well as the occasional oral/buccal screens. The screens have been consistently negative for non-prescribed medications, alcohol, and illicit drugs and they have confirmed her compliance with buprenorphine. She is active in AA and has organized several of the local and regional programs and conferences associated with AA. She is involved in service work for AA and is currently serving as sponsor for several individuals. She has also become one of our peer counselors for hospitalized patients with substance use disorders who have been admitted for medical reasons. She volunteers her time meeting with them and also brings in AA meetings via the "Accessibility" group during their hospitalization. She has taken some formal coursework through the National counsel on Alcohol and Drug Dependence (DePauls) related to this. Ms. XX is working, involved in a healthy relationship, she is sober and compliant. It is my opinion that she is well established in recovery and has an excellent prognosis for continued sobriety and good health.

Sincerely,

Testing Panels

- Oral assay (immunoassay –ELISA below left)
- Testing panel options (urine) example – below right

Specimen Type: ORAL FLUID

Profile Ordered	
Test(s) Requested:	OF206000 - Ethyl Alcohol
Test(s) Requested:	8430 - ORAL FLUID DRUG SCREEN ONLY W/AMP

TESTS PERFORMED

*Units for Cut Off and Value are in ng/mL

*Units for Ethanol (Alcohol) Cut Off and Value are reported as mg/dL

Test Name	Test Result	Value*	Cut Off *	Note
Amphetamines				
Methamphetamine [8]	Negative		50	
Benzodiazepines [8]	Negative		20	
Buprenorphine [8]	Presumptive POS**		5	
Cannabinoids [8]	Negative		4	
Cocaine Metabolites [8]	Presumptive POS**		20	
Ethanol (Alcohol) [2]	Negative		20	
Methadone [8]	Negative		50	
Opiates - Basic [8]	Negative		40	

Test Method: [2] GC/MS; [8] ELISA Screening;
*Units for Cut Off and Value are in ng/mL
*Units for Ethanol (Alcohol) are reported as mg/dL

(**) This is an unconfirmed screening result and should be used only for medical (i.e., treatment) purposes. Unconfirmed screening results must not be used for non-medical purposes. If confirmation by a more specific technique is needed please contact Drugscan Customer Service at 800-235-4890.
The LC/MS/MS and GC/MS/MS tests are high complexity laboratory developed tests and their performance characteristics determined by DRUGSCAN.

Specimen Type: URINE

Profile Ordered	
Test(s) Requested:	640240 - Buprenorphine Screen with Naloxone
Test(s) Requested:	610817 - CUSTOM TOX PROFILE HD - 10817
Test(s) Requested:	640230 - Ethylglucuronide Screen (500/100)
Test(s) Requested:	640260 - Fentanyl Screen ACM
Test(s) Requested:	616450 - Gabapentin
Reflex Ordered:	620010 - Buprenorphine & Naloxone
Reflex Ordered:	600020 - Buprenorphine Creatinine Ratio
Reflex Ordered:	625020 - Fentanyl & Norfentanyl (0.5/10)
Reflex Ordered:	600030 - Norbuprenorphine Creatinine Ratio

Panelist question

- What testing panels are you using for patients with Opioid Use Disorder?
  - What analytes/drugs do you usually test for? Can you comment on cost?

- Are you using immunoassay testing in the office (or other) setting?

Urine Results Reporting Vary

- Free
- Conjugates
- Total
- vs/Cr
- [Naloxone]
- Cr

Test Name	Test Result	Value*	Cut Off *
Amphetamines [1]	Negative		300
Barbiturates [1]	Negative		200
Benzodiazepines [1]	Negative		50
Buprenorphine/Naloxone			
Buprenorphine [1][3]	Positive	>4800	5
Buprenorphine/Creatinine Ratio		8988	
Naloxone [3]	Positive	>1200	5
Norbuprenorphine [1][3]	Positive	38.7	5
Norbuprenorphine/Creatinine Ratio		72	
Cannabinoids			
Marijuana Metabolite [1]	Negative		20
Cocaine Metabolites [1]	Negative		150
ETG/ETS [1]	Negative		100
Fentanyls			
Fentanyl [1][3]	Positive	0.7	2/0.5
Fentanyl Metabolite [1][3]	Negative		2/10
Methadone [1]	Negative		150
Neuroleptics			
Gabapentin [3]	Negative		500
Opiates - Basic [1]	Negative		100
Oxycodone/Oxymorphone [1]	Negative		100
Phencyclidine (PCP) [1]	Negative		25

Elements	08/19/13 10:20 AM
BUPRENORPHINE,UR *	12
BUPREN GLUC,UR *	126
TOTAL BUPREN,UR *	103
TOTAL BUP/CREAT,UR *	61
NORBUPRENORPHINE,UR *	47
NORBUPREN GLUC,UR *	190
TOTAL NORBUPREN,UR *	180
TOTAL NORBUP/CREAT,UR *	106
CREATININE, UR *	170

Prior research on metabolite profile interpretation

- Summary of previous research on urine metabolite interpretation
- Naloxone concentration interpretation

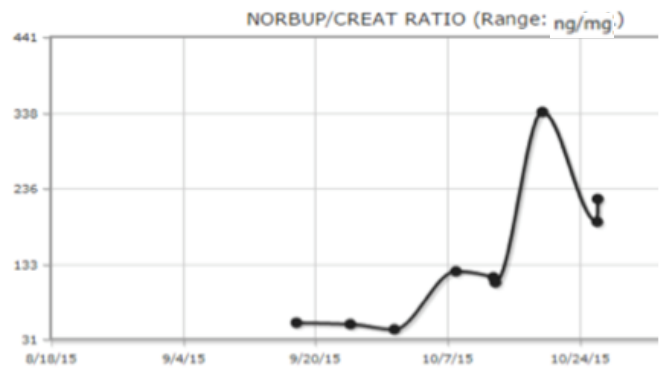
Buprenorphine Metabolite Profiles in Urine

- Buprenorphine and norbuprenorphine quantification in urine
  - When standardized to Cr, norbuprenorphine can help providers understand how patients are taking buprenorphine
  - Fluctuations over time can prompt questions about dosing/compliance.
  - High levels of buprenorphine vs low levels of norbuprenorphine suggest 'spiked' urine.
- A compliant patient will have fairly low levels of buprenorphine and higher levels of the metabolites (norbuprenorphine) –if measuring only free buprenorphine
  - Intermittent buprenorphine use will have much lower metabolite levels
- Urine Creatinine allows for standardization of levels despite fluctuations in urine concentration.

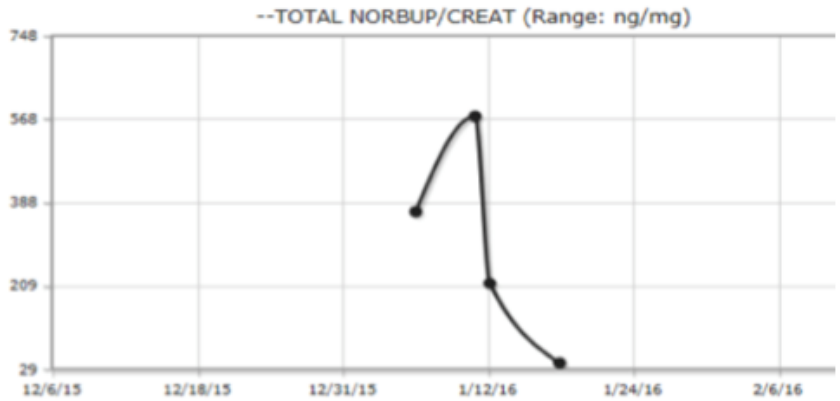
Fareed 2013 and Wiegand 2016 (references at end of slides)

Wiegand TJ, poster 2016

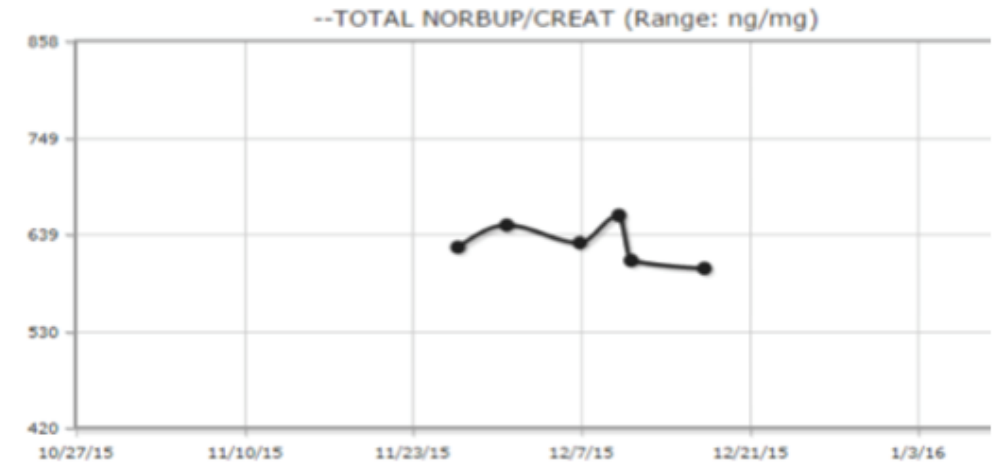
'Street' use buprenorphine to induction



Starting stable dosing to abruptly d/c dosing



Stable dosing of buprenorphine



TOXICOLOGY, URINE	
Drug Remark,UR	*see text*
Add'l Drugs,UR	*See Text()*
Amphetamine,UR	*NEG*
Barbiturate,UR	*NEG*
Benzodiazepinen,UR	*NEG*
THC Metabolite,UR	*NEG*
Cocaine/Metab,UR	*NEG*
Opiates,UR	*POS*
Confirm Opiates	*POS*
Propoxyphene,UR	*NEG*
BUPRENORPHINE,UR	*>4000*
Bupren Gluc,UR	*<5*
Norbuprenorphine,UR	*10*
Norbupren Gluc,UR	*<2*
T. Norbupren,UR	*10*
T. Norbup/Cr,UR	*25*

'spiked urine' with bup/naloxone and use heroin

Confirm Opiates

Collected:	10/03/15 1653
Resulting lab:	STRONG MEMORIAL HOSPITAL
Value:	POS
Comment:	Morphine (conjugated and un-conjugated) Present (cut-off 50 ng/mL) Naloxone (Narcan) Present (cut-off 100 ng/mL)

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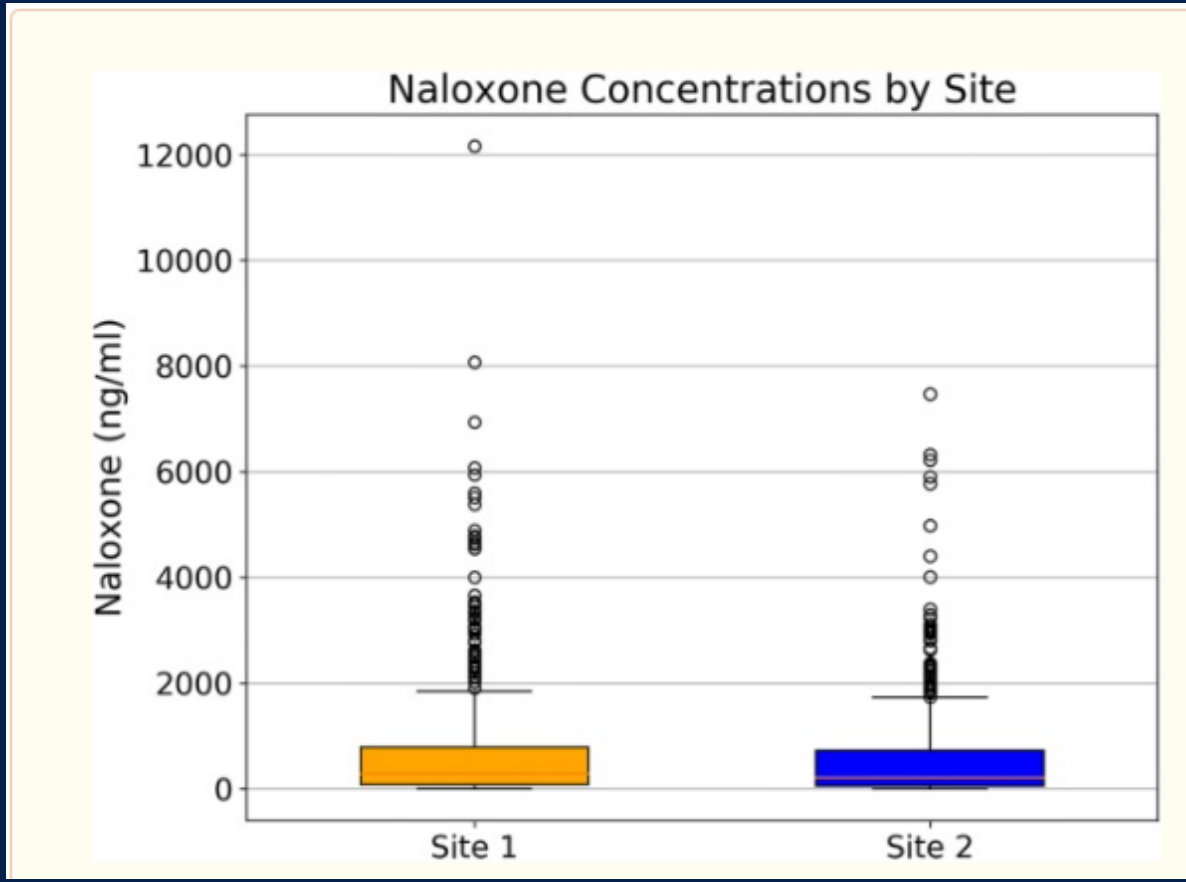
Naloxone in Urine

- 1123 patient samples
- 275 unique patients
- 2 sites
- Range 0 to 12,161 ng/mL
- Average naloxone 633.65 ng/mL
- 1 s.d. 1039.38 ng/mL
- Median naloxone 253 ng/mL
  - 1st quartile 57.5 ng/mL
  - 3rd quartile 762 ng/mL
- 8% samples ‘extreme’ [naloxone] > 2000 ng/mL*



Warrington JS, et al. Use of urinary naloxone levels in a single provider practice: a case study. Addiction Science & Clinical Practice. 2020; 15:3. PMID: 31941557.

Naloxone in Urine

- Concentrations may vary due to individual differences in absorption, metabolism, and excretion.
- Genetic variation, nutrition, concurrent medication, hepatic impairment may alter urine naloxone levels.
- Lab reporting (free vs total) can result in variability by lab and high levels without 'spiking'.
- Naloxone conjugates are not pharmacologically active and accumulate over time (*longer elimination half-life*).
- **Naloxone levels need to be interpreted along with buprenorphine metabolite profiles.**
- Naloxone levels vary –*lower for stable patients vs 'unstable'*

Warrington JS, et al. Use of urinary naloxone levels in a single provider practice: a case study. Addiction Science & Clinical Practice. 2020; 15:3. PMID: 31941557.

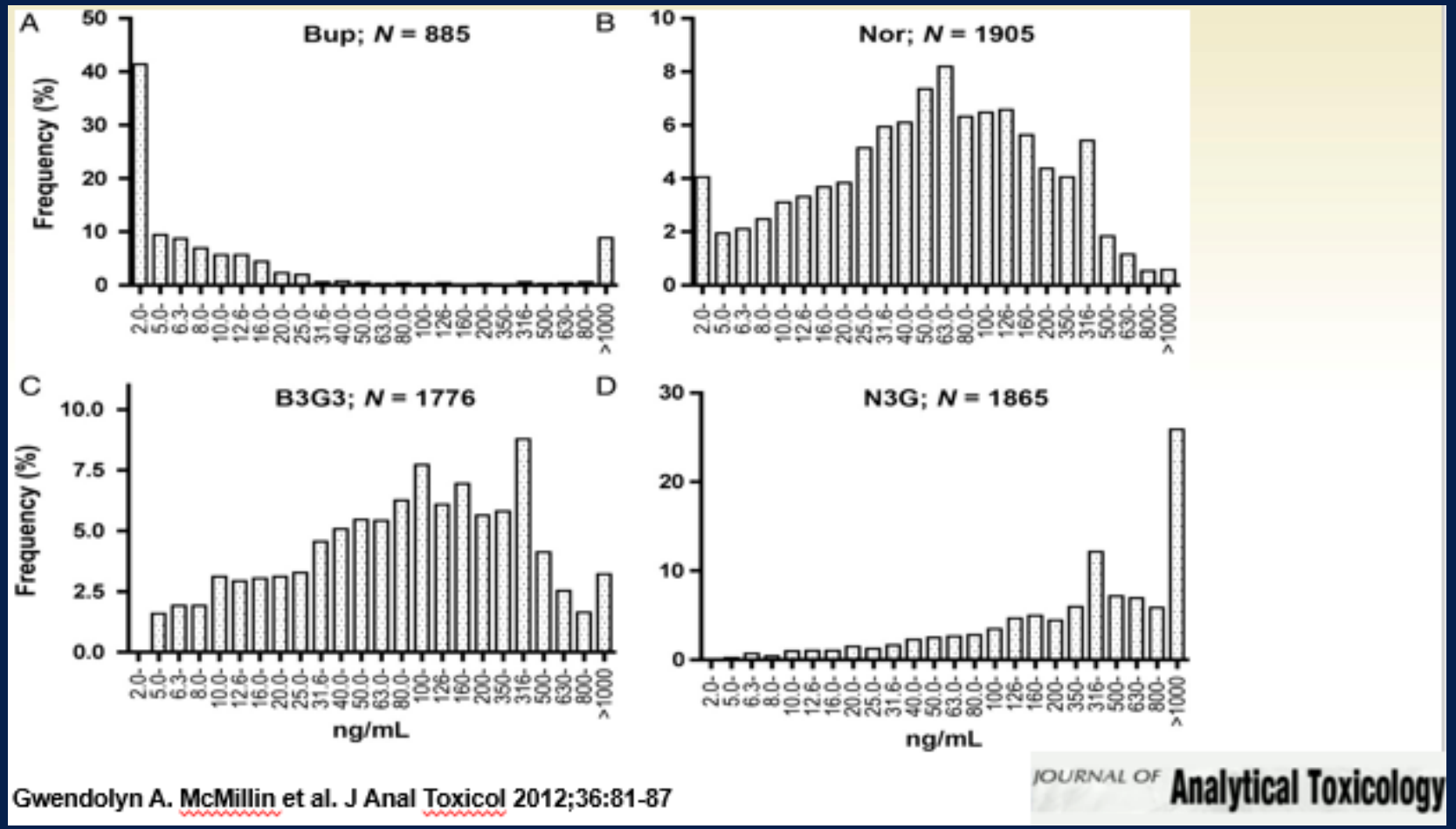
Buprenorphine, metabolite and naloxone variation at various stages of treatment

- Group 0 = pre-treatment but use IV, IM or IN buprenorphine
- Group 1 stable patients SL BNX maintenance. *UDS 24 hours after SL dose.*
- Group 2 is 'unstable' (use other substances or illicit use BNX)

	Group 0 N = 9	Group 1 N = 13	Group 2 N = 18	P†
Buprenorphine (µg/L)	90.0, 130.9, (17.5, 250.0), 9.7–350.0	88.0, 157.5, (50.5, 175.0), 8.9–850.0	180.0, 368.1, (76.3, 557.5), 9.0–2000.0	NS
Norbuprenorphine (µg/L)	74.0, 177.1, (36.0, 270.0), 14.0–710.0	630.0, 623.0, (225.0, 895.0), 59.0–1600.0	770.0, 940.7, (390.0, 1400.0), 190.0–2700.0	p = 0.001
Naloxone (µg/L)	0.0, 57.1, (0-107.0), 0 –300.0	60.0, 60.3, (7.0, 90.0), 5.0–200.0	70.0, 299.4, (20.0, 205.0), 10.0–1700.0	p = 0.012
Norbuprenorphine/ buprenorphine ratio	1.6, 1.5, (0.7, 2.1), 0.5 –2.6	6.5, 6.1, (4.3, 8.6), 1.0 –10.0	3.6, 7.6, (1.9, 11.4), 0.4 –27.0	p = 0.003
Naloxone/ buprenorphine ratio	0.0, 0.2, (0.0-0.5), 0.0 –1.0	0.6, 0.7, (0.2, 0.8), 0.05–2.6	0.5, 1.2, (0.2, 1.0), 0.06 –8.9	p = 0.025

Heikman P, et al. Urine naloxone concentration at different phases of buprenorphine maintenance treatment. Drug Testing and Analysis. 2014 Mar;6(3): 220-5. PMID: 23512803.

Frequency distribution of positive quantitative results for free (unconjugated) buprenorphine (Bup) (A) and free (unconjugated) norbuprenorphine (Nor) (B) and semi-quantitative results for buprenorphine-glucuronide (B3G) (C) and norbuprenorphine-glucuronide (N3G) (D).



Gwendolyn A. McMillin et al. J Anal Toxicol 2012; 36: 81-87.

Buprenorphine metabolite profiles

- Specimens containing more than 100 ng/mL free buprenorphine (*need to differentiate Total buprenorphine from buprenorphine/buprenorphine glucuronide**) are suspected of adulteration.
- Samples > 100 ng/mL* amounted to 4% of the examined database (*in one study*).
  - *Usually very high levels of bup e.g. >4000 ng/mL
- Adulteration of samples occurs from placement of medication directly into the urine container (may also see naloxone if combined formulation).
- Adulteration detected by quantitative analysis of free buprenorphine and free naloxone concentrations in urine.

Gwendolyn A. McMillin et al. J Anal Toxicol 2012; 36: 81-87.

Patterns of buprenorphine, naloxone, and metabolite in urine of adulterated/spiked samples

Patterns of Free (Unconjugated) Buprenorphine, Norbuprenorphine, and Their Glucuronides in Urine Using Liquid Chromatography–Tandem Mass Spectrometry

Table III
Buprenorphine, Norbuprenorphine, and Naloxone Concentrations in Suspect Samples

Sample	Buprenorphine (ng/mL)	Norbuprenorphin(ng/mL)	Naloxone (ng/mL)	Buprenorphine / Naloxone	Norbuprenorphine / Buprenorphine
1	4160	16.5	5420	0.77	0.00397
2	7500	4.9	2140	3.50	0.00065
3	10900	6.8	3010	3.62	0.00062
4	31100	20.1	8500	3.66	0.00065
5	11100	11.8	2920	3.80	0.00106
6	12100	13.7	3110	3.89	0.00113
7	20200	22.7	5160	3.91	0.00112
8	39200	36.3	9560	4.10	0.00093
9	18800	30.8	4430	4.24	0.00164
10	19300	10.6	4470	4.32	0.00055
11	39400	23.6	6690	5.89	0.00060
12	15000	7.2	2300	6.52	0.00048

Gwendolyn A. McMillin et al. J Anal Toxicol 2012; 36: 81-87.

First –is the sample valid?

- Buprenorphine 88 ng/mL
- Norbuprenorphine 375 ng/mL
- Cr 85.7 mg/dL

DRUG TOX MONITORING BUPRENORPHINE,QUANT,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
BUPRENORPHINE QUANT See note #1	88	CUTOFF=2	NG/ML	A
NORBUPRENORPHINE QUANT See note #1	375	CUTOFF=2	NG/ML	A

DRUG TOX MONITORING ETHYL ALCOHOL,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
ETHANOL SCREEN CUTOFF=20	NEGATIVE	CUTOFF=20	MG/DL	

DRUG TOX MONITORING BENZODIAZEPINES,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
BENZODIAZEPINES See note #1	NEGATIVE	CUTOFF=100	NG/ML	

DRUG TOX MONITORING COCAINE METABOLITE,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

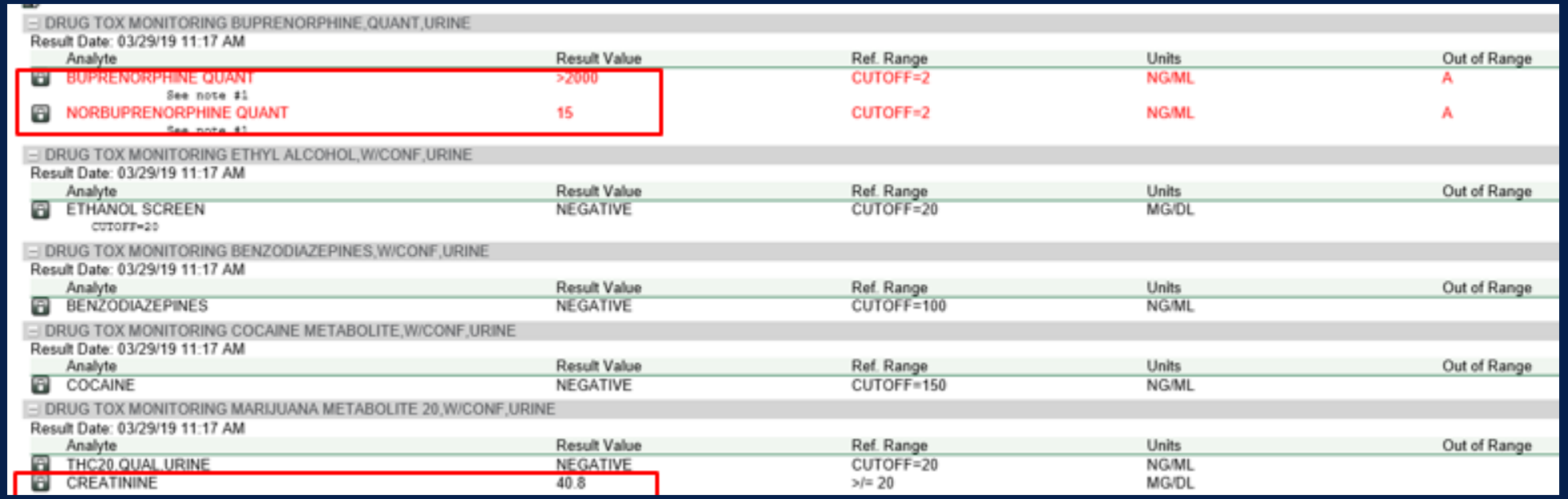
Analyte	Result Value	Ref. Range	Units	Out of Range
COCAINE	NEGATIVE	CUTOFF=150	NG/ML	

DRUG TOX MONITORING MARIJUANA METABOLITE 20,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
THC20,QUAL,URINE	NEGATIVE	CUTOFF=20	NG/ML	
CREATININE	81.7	>/= 20	MG/DL	

How do you Interpret this Sample?

- Buprenorphine quantification > 2000 ng/mL
- Norbuprenorphine 15 ng/mL (low) and Cr 40.8 mg/dL



DRUG TOX MONITORING BUPRENORPHINE,QUANT,URINE
Result Date: 03/29/19 11:17 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
BUPRENORPHINE QUANT See note #1	>2000	CUTOFF=2	NG/ML	A
NORBUPRENORPHINE QUANT	15	CUTOFF=2	NG/ML	A

DRUG TOX MONITORING ETHYL ALCOHOL,W/CONF,URINE
Result Date: 03/29/19 11:17 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
ETHANOL SCREEN CUTOFF=20	NEGATIVE	CUTOFF=20	MG/DL	

DRUG TOX MONITORING BENZODIAZEPINES,W/CONF,URINE
Result Date: 03/29/19 11:17 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
BENZODIAZEPINES	NEGATIVE	CUTOFF=100	NG/ML	

DRUG TOX MONITORING COCAINE METABOLITE,W/CONF,URINE
Result Date: 03/29/19 11:17 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
COCAINE	NEGATIVE	CUTOFF=150	NG/ML	

DRUG TOX MONITORING MARIJUANA METABOLITE 20,W/CONF,URINE
Result Date: 03/29/19 11:17 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
THC20 QUAL URINE	NEGATIVE	CUTOFF=20	NG/ML	
CREATININE	40.8	>/= 20	MG/DL	

Specimen Validity Testing (SVT)

- SVT is performed to assess whether substitution, adulteration or dilution occurred
  - **Substitution** is submission of a specimen that is not human urine or is from another person (a 'valid' specimen) temperature, creatinine and specific gravity help determine whether a specimen has been substituted or not
  - **Adulteration** is the addition of chemicals to a urine specimen that will mask or destroy drugs or their metabolites (nitrates, acids, oxidizing/reducing agents)
  - **Dilution** may be intentional (drinking large amounts of water before providing a specimen) or the result of physiologic conditions (i.e. diabetes)

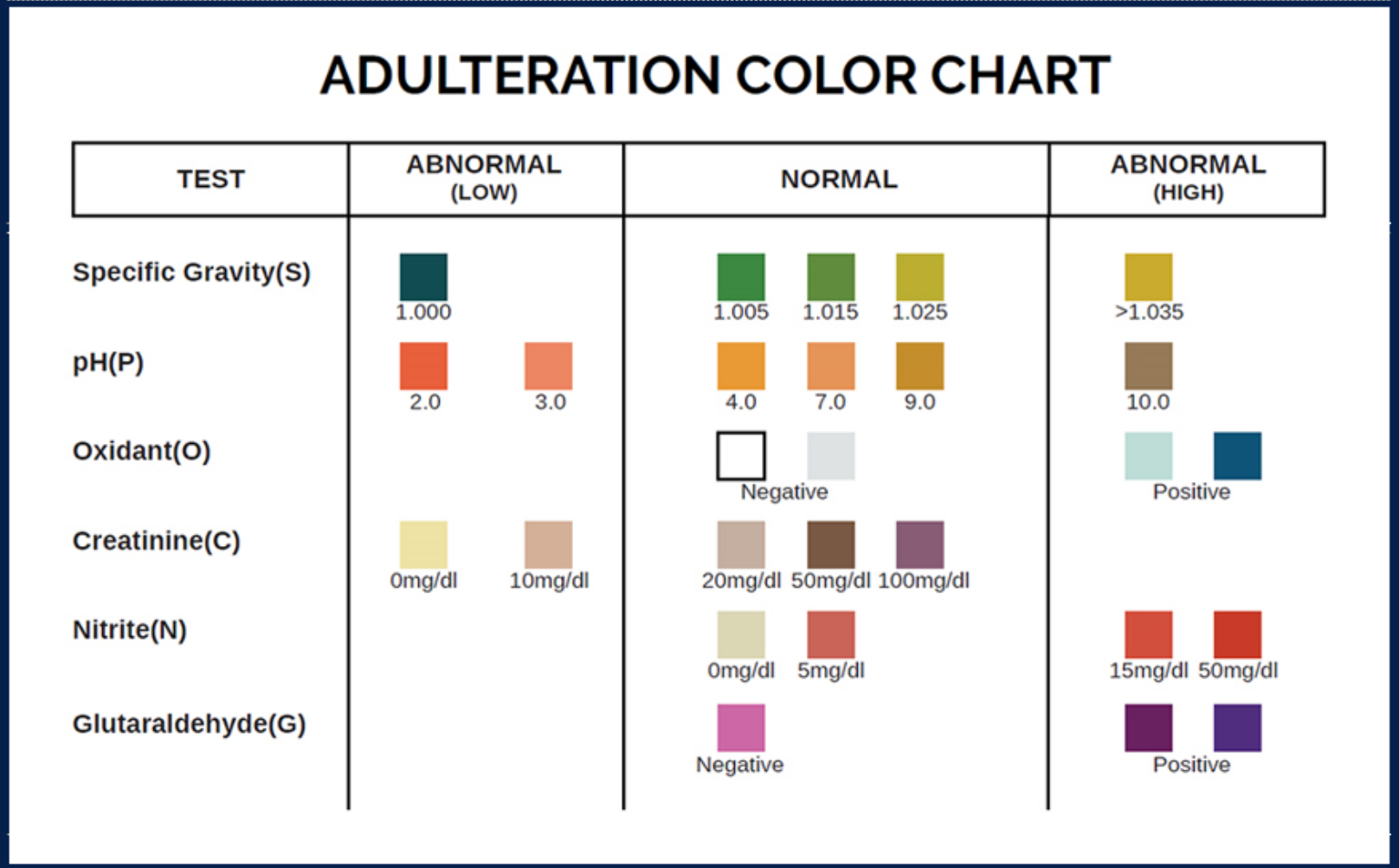
Drug Testing Considerations

- Specimen Validity Testing:
  - Temperature
  - pH and volume of sample
  - Specific Gravity (S.G.)
  - Creatinine (> 20 mg/dL)

VALIDITY TESTING

Test Name	Screening Range	Result	Units	Method	Comment
Creatinine	>20.00	53.4	mg/dL	Colorimetric	
Nitrite	<200	32.2	mcg/mL	Colorimetric	
pH	4.50 - 9.00	5.9		Colorimetric/pH Meter	

One method of testing samples



https://premierbiotech.com/innovation/ar-dcfs-certified-training/

Adulteration

- Buprenorphine/norbuprenorphine ratio of > 50:1 (Accurso, et al 2017)
- Buprenorphine > = *700 ng/mL (Donroe, et al 2017)*
- Buprenorphine > 2000 ng/mL, with a mean norbuprenorphine level of 11.9 ng/mL. (Suzuki, et al 2017)
- Free Buprenorphine >100 ng/mL with low metabolite concentrations (McMillin et al 2012)

Accurso, et al 2017, Donroe, et al 2017, Suzuki, et al 2017 and McMillin et al 2012, full citation at References

Example of Adulteration

- **Buprenorphine/norbuprenorphine > 50:1**
- Buprenorphine > 4800 ng/mL
  - Buprenorphine > 700 ng/mL
- Norbuprenorphine = 38.7
- Naloxone > 1200* ng/mL

TESTS PERFORMED

*Units for Cut Off and Value are in ng/mL

*Units for Buprenorphine/Creatinine Ratio Cut Off and Value are reported as ng/mg

*Units for Norbuprenorphine/Creatinine Ratio Cut Off and Value are reported as ng/mg

Test Name	Test Result	Value*	Cut Off *	Note
Amphetamines [1]	Negative		300	
Barbiturates [1]	Negative		200	
Benzodiazepines [1]	Negative		50	
Buprenorphine/Naloxone				
Buprenorphine [1][3]	Positive	>4800	5	
Buprenorphine/Creatinine Ratio		8988		Calculation based on ULOL.
Naloxone [3]	Positive	>1200	5	
Norbuprenorphine [1][3]	Positive	38.7	5	
Norbuprenorphine/Creatinine Ratio		72		
Cannabinoids				
Marijuana Metabolite [1]	Negative		20	
Cocaine Metabolites [1]	Negative		150	
ETG/ETS [1]	Negative		100	
Fentanyls				
Fentanyl [1][3]	Positive	0.7	2/0.5	
Fentanyl Metabolite [1][3]	Negative		2/10	
Methadone [1]	Negative		150	
Neuroleptics				
Gabapentin [3]	Negative		500	
Opiates - Basic [1]	Negative		100	
Oxycodone/Oxymorphone [1]	Negative		100	
Phencyclidine (PCP) [1]	Negative		25	

How do you interpret this sample?

- Sample with buprenorphine of 309 ng/mL and 0 nor-buprenorphine. Cr is 0.1 mg/dL.

DRUG TOX MONITORING BUPRENORPHINE,QUANT,URINE
Result Date: 05/03/19 12:54 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
BUPRENORPHINE QUANT See note #1	309	CUTOFF=2	NG/ML	A
NORBUPRENORPHINE QUANT See note #1	NEGATIVE	CUTOFF=2	NG/ML	

DRUG TOX MONITORING ETHYL ALCOHOL,W/CONF,URINE
Result Date: 05/03/19 12:54 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
ETHANOL SCREEN CUTOFF=20	NEGATIVE	CUTOFF=20	MG/DL	

DRUG TOX MONITORING BENZODIAZEPINES,W/CONF,URINE
Result Date: 05/03/19 12:54 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
BENZODIAZEPINES	NEGATIVE	CUTOFF=100	NG/ML	

DRUG TOX MONITORING COCAINE METABOLITE,W/CONF,URINE
Result Date: 05/03/19 12:54 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
COCAINE	NEGATIVE	CUTOFF=150	NG/ML	

DRUG TOX MONITORING MARIJUANA METABOLITE 20,W/CONF,URINE
Result Date: 05/03/19 12:54 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
THC20, QUAL,URINE	NEGATIVE	CUTOFF=20	NG/ML	
CREATININE	0.1	>/= 20	MG/DL	L

How do you interpret this sample?... Sample with buprenorphine of 309 ng/mL and 0 nor-buprenorphine. Cr is 0.1 mg/dL.

- Dilution
- Adulteration
- Dilution and Adulteration
- No manipulation of the urine sample

Audience Poll on last slide

- A.) Dilution
- B.) Adulteration
- C.) Dilution and Adulteration
- D.) No manipulation of the urine sample

How do you interpret this sample?

- Buprenorphine 88 ng/mL
- Norbuprenorphine 375 ng/mL
- Cr 81.7 mg/dL

DRUG TOX MONITORING BUPRENORPHINE,QUANT,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
BUPRENORPHINE QUANT See note #1	88	CUTOFF=2	NG/ML	A
NORBUPRENORPHINE QUANT See note #1	375	CUTOFF=2	NG/ML	A

DRUG TOX MONITORING ETHYL ALCOHOL,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
ETHANOL SCREEN CUTOFF=20	NEGATIVE	CUTOFF=20	MG/DL	

DRUG TOX MONITORING BENZODIAZEPINES,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
BENZODIAZEPINES See note #1	NEGATIVE	CUTOFF=100	NG/ML	

DRUG TOX MONITORING COCAINE METABOLITE,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
COCAINE	NEGATIVE	CUTOFF=150	NG/ML	

DRUG TOX MONITORING MARIJUANA METABOLITE 20,W/CONF,URINE
Result Date: 09/11/18 09:51 AM

Analyte	Result Value	Ref. Range	Units	Out of Range
THC20,QUAL,URINE	NEGATIVE	CUTOFF=20	NG/ML	
CREATININE	81.7	>/= 20	MG/DL	

How do you interpret this sample?... Buprenorphine 88 ng/mL; Norbuprenorphine 375 ng/mL; Cr 81.7 mg/dL

- Dilution
- Adulteration
- Dilution and Adulteration
- No manipulation of the urine sample

Audience Poll on last slide

- A.) Dilution
- B.) Adulteration
- C.) Dilution and Adulteration
- D.) No manipulation of the urine sample

Summary of Previous Research

- Dilution
  - Check Cr level (if <20mg/dL concern for sample validity)
- Adulteration
  - Check ratio between buprenorphine and norbuprenorphine (>50:1 indicates adulteration)
  - Consider naloxone levels (along with other profile results)

Buprenorphine Dosage and Urine Quantitative Buprenorphine, Norbuprenorphine, and Creatinine Levels in an Office-Based Opioid Treatment Program

Hiroko Furo[1,2], Diane G Schwartz[1], Ross W Sullivan[3] and Peter L Elkin[1]

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SAGE

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Recent Publication

- Retrospective chart review
- 240 urine samples from 41 patients
- Buprenorphine administration was observed among half-way house residents
- Buprenorphine, norbuprenorphine and creatinine levels were quantified in the urine
- Distributions of the patients' dosages were compared
- Norbuprenorphine/creatinine ratios compared for 8, 12 and 16 mg dosage groups

Inclusion Criteria

- One year study period of patients with Opioid Use Disorder in a halfway-house (HWH) setting.
- Subjects needed at least 6 days residence in HWH setting.
- Patients prescribed buprenorphine, confirmed via Prescription Drug Monitoring Program (PDMP).
- Lab results with urine buprenorphine, norbuprenorphine and creatinine levels confirmed and quantified.

Exclusion Criteria

- Samples positive for other substances (e.g. THC) – one
- Urine samples with creatinine results < 20 mg/dL – none
- Buprenorphine/norbuprenorphine ratio > 50:1 - none
- *If the buprenorphine or norbuprenorphine levels were > 2000 ng/mL → they were calculated as 2000 ng/mL*
  - *Lab threshold for detection was maximum of 2000 for analytes.*

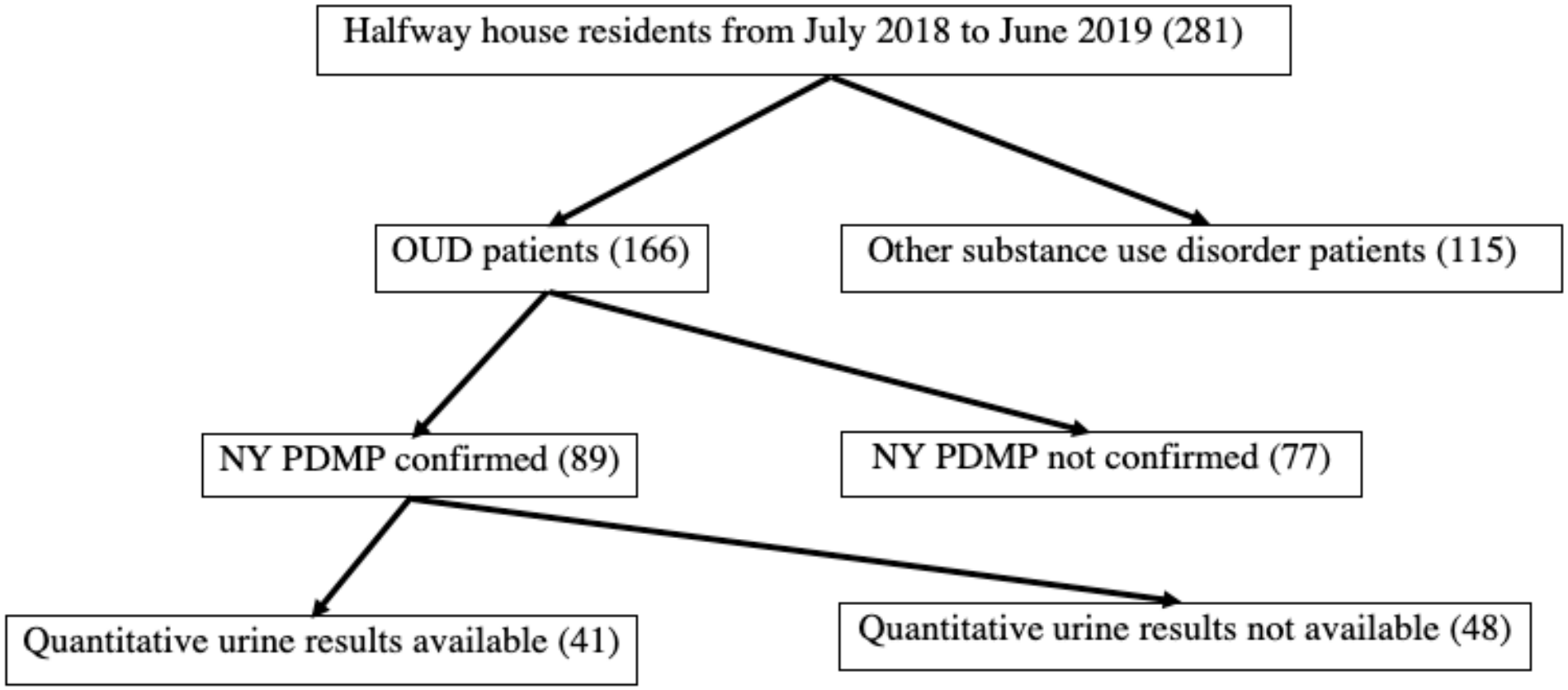


Figure 1. Patient selection process.

The number in each box indicates the number of patients in each category. OUD, opioid use disorder; PDMP, Prescription Drug Monitoring Program.

Demographic Information (n = 41)

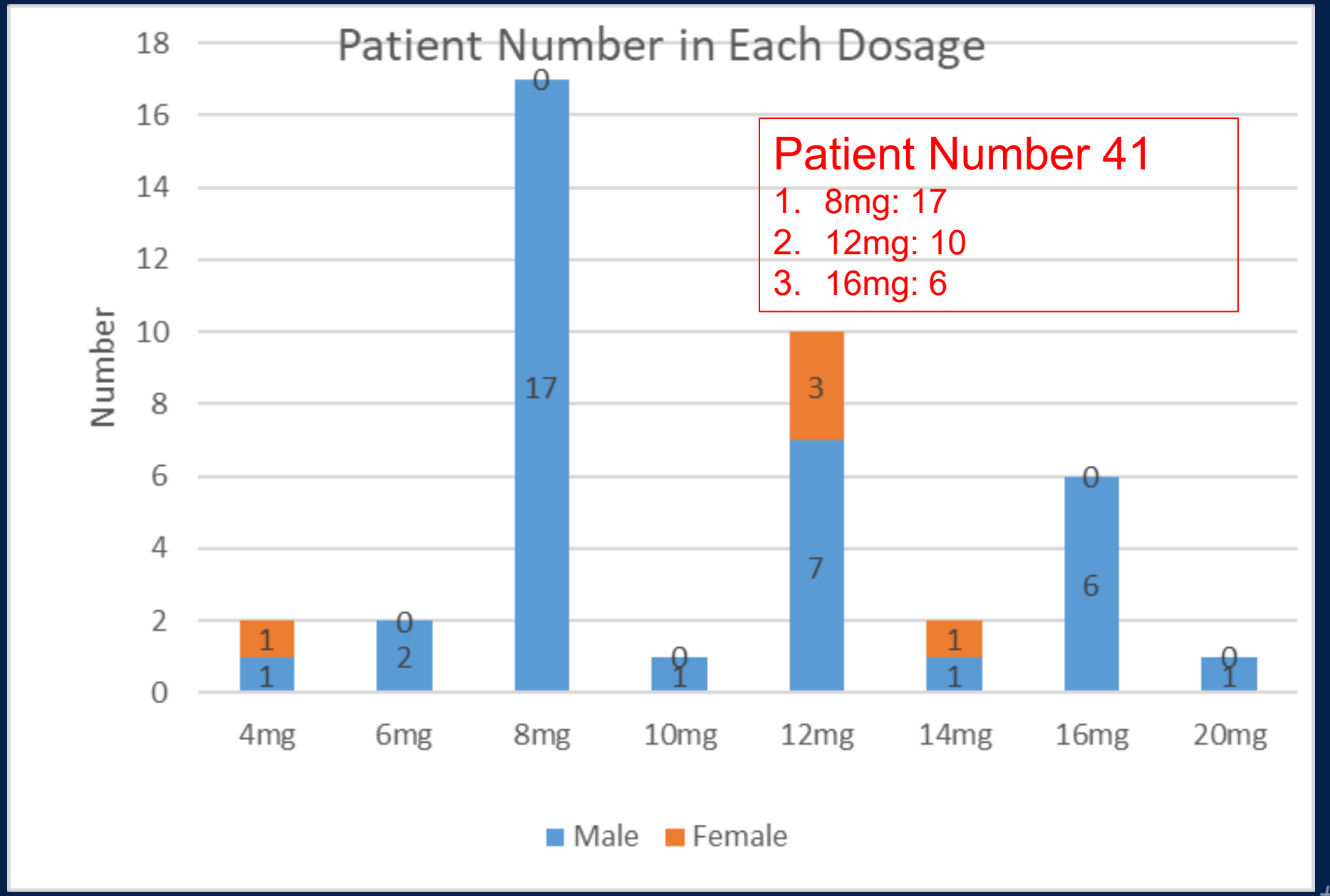
Characteristic (n=41)	Mean ± SD or n(%)	Range
Age (y)	34.8 ± 8.8	25 - 63
Sex, male	36 (87.8%)	
Ethnicity		
White	36 (87.8%)	
African American	3 (7.1%)	
Hispanic	1 (2.4%)	
Other	1 (2.4%)	
Marital status		
Single	38 (92.7%)	
Divorced	2 (4.9%)	
Separated	2 (4.9%)	
Married	1 (2.4%)	
Employment		
Unemployed	41 (100%)	

Characteristic (n=41)	Mean ± SD or n(%)	Range
Days in HWH	13.2 ± 98.7	12 - 351
BMI (kg/m^2)	26.8 ± 3.7	21 - 40
Smoking		
Smoker	38 (92.7%)	
Former smoker	2 (4.9%)	
Never	1 (2.4%)	
Veterans	1 (2.4%)	
Education		
<High school	7 (17.1%)	
High school	12(29.3%)	
Some college	11 (34.4%)	
Bachelor's	2 (4.9%)	

Analysis Method

- Deidentified subject urine levels reported for buprenorphine, norbuprenorphine, creatinine were paired with buprenorphine dosage listed in spreadsheet.

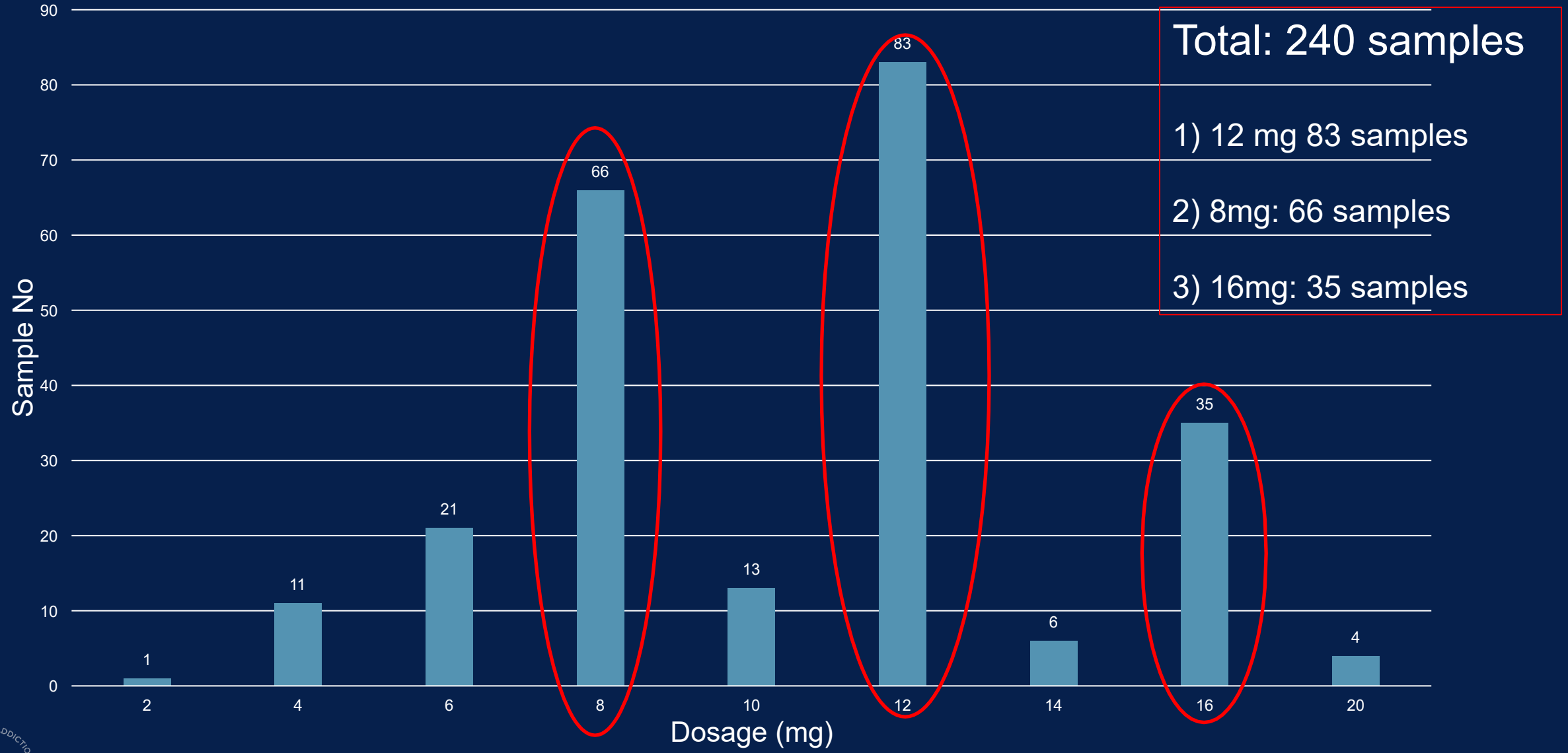
- Data analysis via descriptive statistics and analysis of variance.



Males N=36

Females N= 5

Urine Sample Number



Total: 240 samples

1) 12 mg 83 samples

2) 8mg: 66 samples

3) 16mg: 35 samples

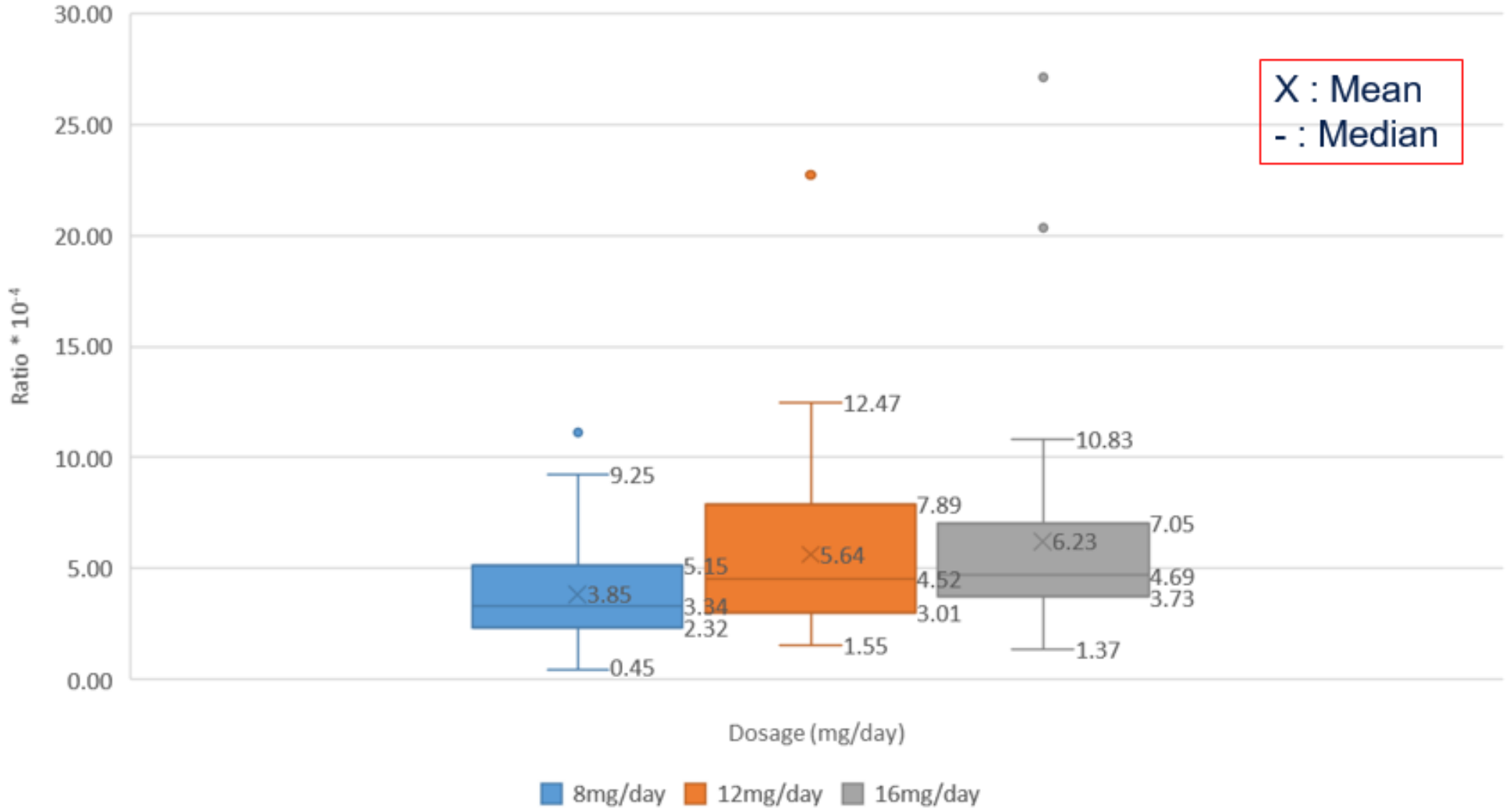
#ASAMAnnual2022

Summary of urine analysis in the three largest dosage groups

Group	8 mg/day (n = 66)	12 mg/day (n = 83)	16 mg/day (n = 35)
Buprenorphine (ng/mL)			
Range	8–1,530	24–>2,000	63–1,220
Mean ± SD	260 ± 304	388 ± 380	334 ± 259
Norbuprenorphine (ng/mL)			
Range	45–>2000	81–>2,000	164–>2,000
Mean ± SD	596 ± 468	780 ± 583	870 ± 560
Creatinine (mg/dL)			
Range	25–428	30–510	49–473
Mean ± SD	149 ± 75	138 ± 72	155 ± 90
Buprenorphine-to-Norbuprenorphine ratio			
Range	0.04–5.82	0.05–2.56	0.11–1.33
Mean ± SD	0.51 ± 0.75	0.56 ± 0.48	0.44 ± 0.25
Correlation coefficient (r)	0.51	0.58	0.72
Buprenorphine-to-creatinine ratio ($X10^{-4}$)			
Range	0.05–8.43	0.14–14.90	0.47–7.85
Mean ± SD	1.58 ± 1.39	2.86 ± 2.45	2.24 ± 1.35
Correlation coefficient (r)	0.57	0.54	0.72
Norbuprenorphine-to-creatinine ratio ($X10^{-4}$)			
Range	0.45–11.12	1.55–22.72	1.37–27.12
Mean ± SD	3.85 ± 2.24	5.64 ± 3.40	6.23 ± 4.92
Correlation coefficient (r)	0.64	0.66	0.53

(*SD, standard deviation)

Norbuprenorphine /Cr Ratio Distribution



ANOVA results

- Norbuprenorphine/Cr ratios among the three groups differed significantly ($p<0.01$).
- Post-hoc analysis: The ratios in the 12- and 16-mg/day dosage groups were similar ($p=0.58$).
- Log-transformed data had similar results.

Result summary

- Buprenorphine dose per day: 4 to 20 mg/day with (mean of 10.5mg).
- The 184 urine samples had Cr levels >20 mg/dL and a buprenorphine/norbuprenorphine ratio <50:1.
- The average norbuprenorphine/Cr ratio:
  - 8mg/day dosage group : 3.85 ± 2.24 × 10-4 (n = 66; range, 0.44–11.12).
  - 12- mg dosage group :5.64 ± 3.40 × 10-4 (n = 83; range 1.55–22.72) .
  - 16-mg dosage groups : 6.23 ± 4.92 × 10-4 (n = 35; range, 1.37–27.12).
- The three dosage groups differed significantly in the mean ratios ($p < 0.01$), except when the 12- and 16-mg dosage groups were compared ($p = 0.58$).

Discussion Points

(1) Unexpected substance(s) in urine sample*

(2) Cr level is < 20 mg/dL (dilution)

(3) bup-to-norbup ratio is > 50:1 (adulteration)

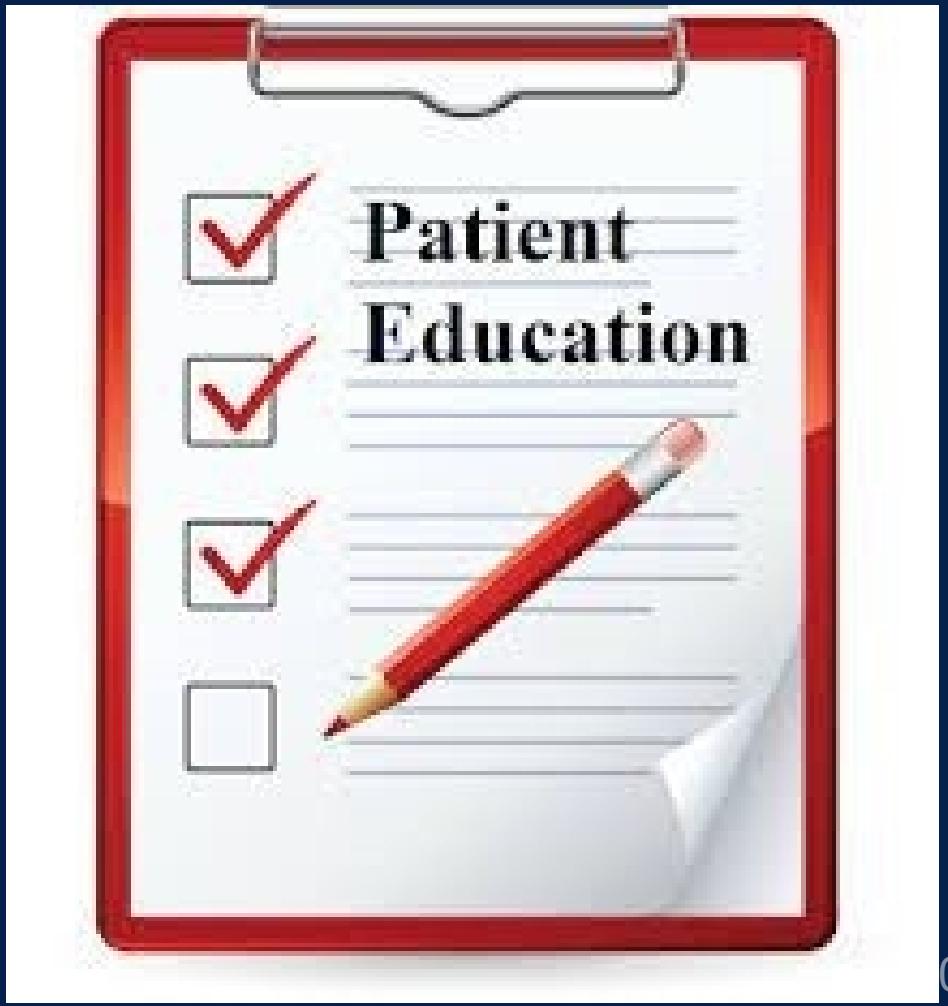
(4) bup dosage over 24 mg/day*

(5) norbup-to-Cr ratio* is consistently below 0.5 in patients treated with 8 mg/day or < 1.5 in patients treated with 12 mg/day or more

**when calculated x 10^{-4}*

Patient education

- SL bup dosing/administration process
- Food or beverage intake
- Smoking during admin
- Discussion of alternative treatments
  - higher level of care
  - transition to SC buprenorphine
  - reinitiation via new techniques e.g., micro induction
  - shorter Rx's/obs dosing, etc.



Back to the beginning… What are your thoughts? Questions?

- A patient is reporting craving taking 8/2 mg of buprenorphine/naloxone BID.
- Requests dose increase to 24 mg/day
- Buprenorphine 6 ng/mL, norbuprenorphine 26 ng/mL, Cr 68 mg/dL

DRUG TOX MONITORING BUPRENORPHINE,QUANT,URINE

Result Date: 06/28/19 12:32 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
BUPRENORPHINE QUANT See note #1	6	CUTOFF=2	NG/ML	A
NORBUPRENORPHINE QUANT See note #1	26	CUTOFF=2	NG/ML	A

DRUG TOX MONITORING ETHYL ALCOHOL,W/CONF,URINE

Result Date: 06/28/19 12:32 PM

Analyte	Result Value	Ref. Range	Units	Out of Range
ETHANOL SCREEN CUTOFF=20	NEGATIVE	CUTOFF=20	MG/DL	

Panelists Comment

- How do you respond to the patient?

- What other information would you like?

Panelists Comment

- How do you respond to the patient?
  - Patient's norbuprenorphine/Cr ratio is < 0.5 and someone taking 16 mg/day it should be at least 1.5 (x 10^{-4})

- What other information would you like?
  - When was sample obtained (e.g., first in clinic represents low level use from street).
  - Other SVT parameters if available.

Oral Testing for Buprenorphine

Specimen Type: ORAL FLUID

Profile Ordered
Test(s) Requested: OF206000 - Ethyl Alcohol
Test(s) Requested: 8430 - ORAL FLUID DRUG SCREEN ONLY W/AMP

TESTS PERFORMED

*Units for Cut Off and Value are in ng/mL

*Units for Ethanol (Alcohol) Cut Off and Value are reported as mg/dL

Test Name	Test Result	Value*	Cut Off *	Note
Amphetamines				
Methamphetamine [8]	Negative		50	
Benzodiazepines [8]	Negative		20	
Buprenorphine [8]	Presumptive POS**		5	
Cannabinoids [8]	Negative		4	
Cocaine Metabolites [8]	Presumptive POS**		20	
Ethanol (Alcohol) [2]	Negative		20	
Methadone [8]	Negative		50	
Opiates - Basic [8]	Negative		40	

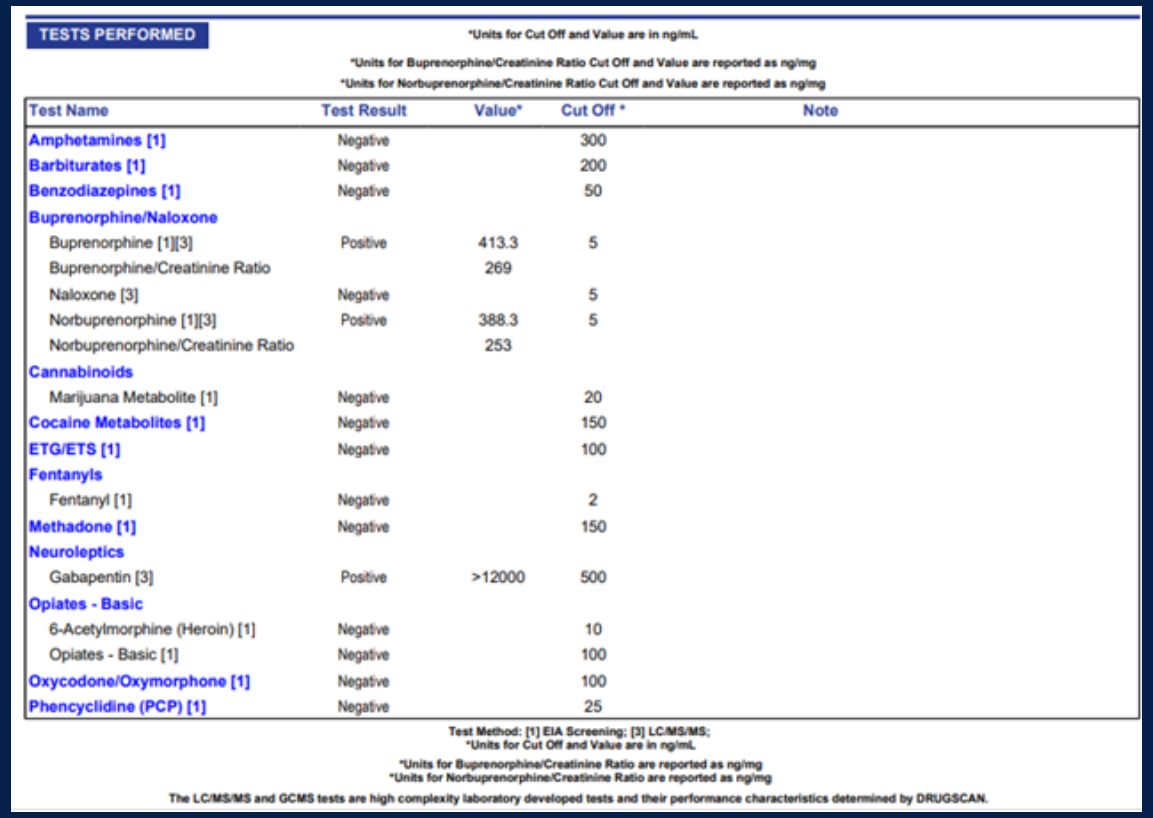
Test Method: [2] GC/MS; [8] ELISA Screening;
*Units for Cut Off and Value are in ng/mL
*Units for Ethanol (Alcohol) are reported as mg/dL

(**) This is an unconfirmed screening result and should be used only for medical (i.e., treatment) purposes. Unconfirmed screening results must not be used for non-medical purposes. If confirmation by a more specific technique is needed please contact Drugscan Customer Service at 800-235-4890.
The LC/MS/MS and GC/MS/MS tests are high complexity laboratory developed tests and their performance characteristics determined by DRUGSCAN.

Panelists –Discuss urine testing with SC buprenorphine

- How would it differ from patients taking buprenorphine/naloxone?
- Discuss prolonged elimination time due to depot effect (urine dip limitations)
- How do you use urine metabolite testing in patients receiving SC buprenorphine?

One month after 300 mg SC (1st injection)



TESTS PERFORMED

*Units for Cut Off and Value are in ng/mL
*Units for Buprenorphine/Creatinine Ratio Cut Off and Value are reported as ng/mg
*Units for Norbuprenorphine/Creatinine Ratio Cut Off and Value are reported as ng/mg

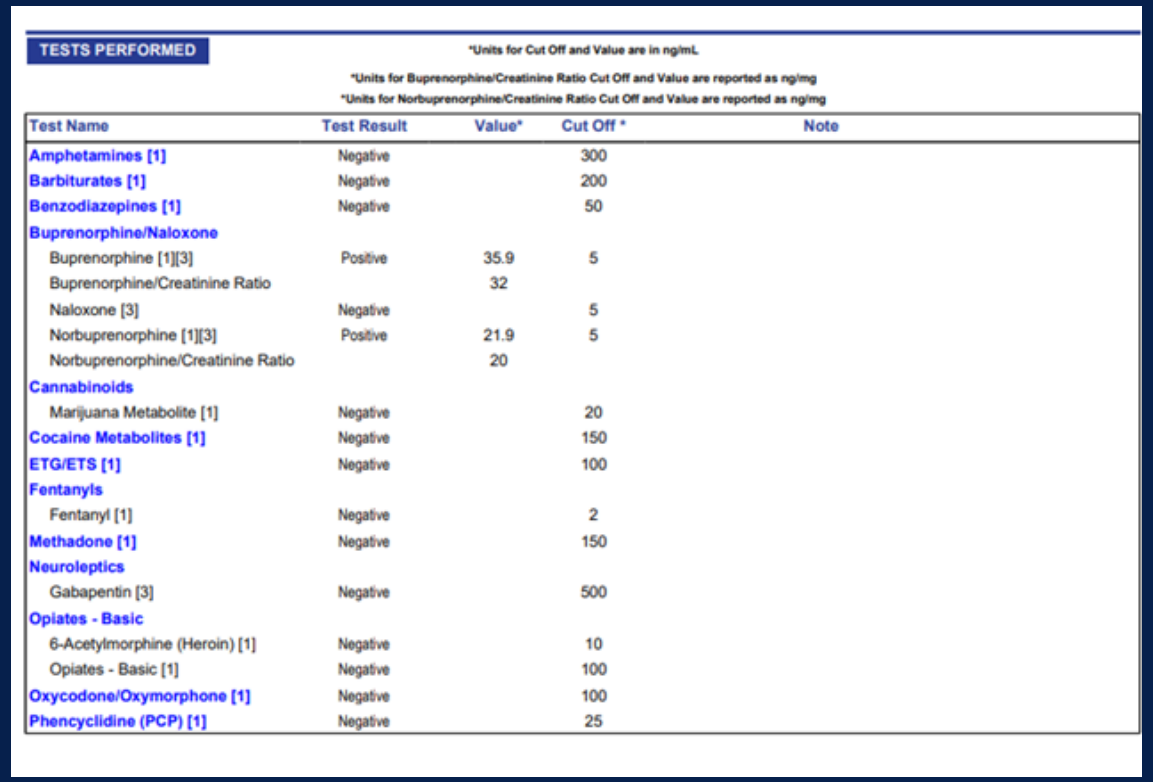
Test Name	Test Result	Value*	Cut Off *	Note
Amphetamines [1]	Negative		300	
Barbiturates [1]	Negative		200	
Benzodiazepines [1]	Negative		50	
Buprenorphine/Naloxone				
Buprenorphine [1][3]	Positive	413.3	5	
Buprenorphine/Creatinine Ratio		269		
Naloxone [3]	Negative		5	
Norbuprenorphine [1][3]	Positive	388.3	5	
Norbuprenorphine/Creatinine Ratio		253		
Cannabinoids				
Marijuana Metabolite [1]	Negative		20	
Cocaine Metabolites [1]	Negative		150	
ETG/ETS [1]	Negative		100	
Fentanyls				
Fentanyl [1]	Negative		2	
Methadone [1]	Negative		150	
Neuroleptics				
Gabapentin [3]	Positive	>12000	500	
Opiates - Basic				
6-Acetylmorphine (Heroin) [1]	Negative		10	
Opiates - Basic [1]	Negative		100	
Oxycodone/Oxymorphone [1]	Negative		100	
Phencyclidine (PCP) [1]	Negative		25	

Test Method: [1] EIA Screening; [3] LC/MS/MS;
*Units for Cut Off and Value are in ng/mL
*Units for Buprenorphine/Creatinine Ratio are reported as ng/mg
*Units for Norbuprenorphine/Creatinine Ratio are reported as ng/mg
The LC/MS/MS and GCMS tests are high complexity laboratory developed tests and their performance characteristics determined by DRUGSCAN.

- Patient transitioned from 16 mg buprenorphine/day to 300 mg/month SC buprenorphine.
  - This result is 4 weeks after the 300 mg/month initial SC buprenorphine injection.

- Buprenorphine 413.3 ng/mL
- Buprenorphine/Cr 269 ng/mg Cr
- Norbuprenorphine 383.3 ng/mL
- Norbuprenorphine/Cr 253 ng/mg

4 injections (2 x 300 mg then 2 x 100 mg)



TESTS PERFORMED

*Units for Cut Off and Value are in ng/mL
*Units for Buprenorphine/Creatinine Ratio Cut Off and Value are reported as ng/mg
*Units for Norbuprenorphine/Creatinine Ratio Cut Off and Value are reported as ng/mg

Test Name	Test Result	Value*	Cut Off *	Note
Amphetamines [1]	Negative		300	
Barbiturates [1]	Negative		200	
Benzodiazepines [1]	Negative		50	
Buprenorphine/Naloxone				
Buprenorphine [1][3]	Positive	35.9	5	
Buprenorphine/Creatinine Ratio		32		
Naloxone [3]	Negative		5	
Norbuprenorphine [1][3]	Positive	21.9	5	
Norbuprenorphine/Creatinine Ratio		20		
Cannabinoids				
Marijuana Metabolite [1]	Negative		20	
Cocaine Metabolites [1]	Negative		150	
ETG/ETS [1]	Negative		100	
Fentanyls				
Fentanyl [1]	Negative		2	
Methadone [1]	Negative		150	
Neuroleptics				
Gabapentin [3]	Negative		500	
Opiates - Basic				
6-Acetylmorphine (Heroin) [1]	Negative		10	
Opiates - Basic [1]	Negative		100	
Oxycodone/Oxymorphone [1]	Negative		100	
Phencyclidine (PCP) [1]	Negative		25	

- Urine results to the left were from 4 months and 1 week after last 100 mg SC injection

- Buprenorphine 35.9 ng/mL
- Buprenorphine/Cr 32 ng/mg

- Norbuprenorphine 21.9 ng/mL
- Norbuprenorphine/Cr 20 ng/mg

Interpretation Exercises

Elements	08/08/13 05:45 PM	07/11/13 05:15 PM	06/18/13 03:30 PM	06/13/13 03:00 PM	06/06/13 01:30 PM	05/07/13 01:30 PM	04/23/13 01:30 PM	04/19/13 03:30 PM
BUPRENORPHINE,UR*	22	< 3	40	4	< 3	9	< 3	< 3
BUPREN GLUC,UR*	2050	505	2780	482	1460	447	279	733
TOTAL BUPREN,UR*	1510	367	2058	354	1060	334	203	532
TOTAL BUP/CREAT,UR*	599	282	702	192	362	198	97	283
NORBUPRENORPHINE,UR*	321	91	587	266	307	188	135	118
NORBUPREN GLUC,UR*	2840	921	2810	1460	2980	1110	932	648
TOTAL NORBUPREN,UR*	2312	737	2557	1289	2396	966	788	572
TOTAL NORBUP/CREAT, UR*	917	567	873	701	818	572	375	304
CREATININE, UR*	252	130	293	184	293	169	210	188

- Pattern variability in someone compliant taking 2-3 of 8/2 mg daily
  - *sometimes forgot 3rd dose*

Interpretation

- 55 year-old M with Opioid Use Disorder taking 8/2 mg SL BID of buprenorphine – naloxone transitions from a detoxification facility to an outpatient clinic (initial clinic UDS results)*

TOXICOLOGY, URINE	
Drug Remark,UR	
Addl Drugs,UR	
Amphetamine,UR	NEG *
Barbiturate,UR	
Benzodiazepinen,UR	NEG *
THC Metabolite,UR	NEG *
Cocaine/Metab,UR	NEG *
Opiates,UR	NEG *
Propoxyphene,UR	
BUPRENORPHINE,UR	9 *
Bupren Gluc,UR	568 *
Total Bupren,UR	421
T. Bup/Creat,UR	260
Norbuprenorphine,UR	175 *
Norbupren Gluc,UR	822 *
T. Norbupren,UR	751
T. Norbup/Cr,UR	464
Ethyl glucuronide ...	

Interpretation Examples

Elements	09/12/13 09:00 AM	08/08/13 06:00 PM	08/05/13 09:00 AM
BUPRENORPHINE,UR*	< 3	< 3	< 3
BUPREN GLUC,UR*	213	76	< 5
TOTAL BUPREN,UR*	155	55	cancelled
TOTAL BUP/CREAT,UR*	129	26	cancelled
NORBUPRENORPHINE,UR*	71	52	< 3
NORBUPREN GLUC,UR*	367	294	< 2
TOTAL NORBUPREN,UR*	328	258	cancelled
TOTAL NORBUP/CREAT,UR*	273	124	cancelled

- Induction for a patient with oxycodone use (60-90 mg/day) *no previous buprenorphine*
  - Initial dose 2/0.5 mg → 8/2 mg
  - Expressed craving still present on day 3 of 8/2 mg daily
  - Increase to 8/2 mg SL BID
  - Next screen one month 9/12/13

Interpretation Exercises

Elements	08/19/13 10:20 AM	08/15/13 04:00 PM	08/09/13 02:30 PM	08/05/13 09:00 AM
BUPRENORPHINE,UR *	12	2860	493	< 3
BUPREN GLUC,UR *	126	210	< 5	< 5
TOTAL BUPREN,UR *	103	3012	493	cancelled
TOTAL BUP/CREAT,UR *	61	4938	1297	cancelled
NORBUPRENORPHINE,UR *	47	32	31	< 3
NORBUPREN GLUC,UR *	190	171	< 2	< 2
TOTAL NORBUPREN,UR *	180	152	31	cancelled
TOTAL NORBUP/CREAT,UR *	106	249	82	cancelled
CREATININE, UR *	170	61	38	223

- What is your interpretation of the various samples?
  - 8/5/13
  - 8/9/13
  - 8/15/13
  - 8/19/13

Additional findings

Elements	08/09/13 02:30 PM
BUPRENORPHINE,UR *	493
BUPREN GLUC,UR *	< 5
TOTAL BUPREN,UR *	493
TOTAL BUP/CREAT,UR *	1297
NORBUPRENORPHINE,UR *	31
NORBUPREN GLUC,UR *	< 2
TOTAL NORBUPREN,UR *	31
TOTAL NORBUP/CREAT,UR *	82
CREATININE, UR *	38

CONFIRM OPIATES **Sample taken on:09-Aug-2013 02:30 PM**

Observation		Value	Reference Range	Units	Note
CONFIRM OPIATES		POS			Naloxone (Narcan) Present (cut-off 100 ng/mL)

Date/time of specimen receipt:12-Aug-2013 01:46 PM Date/time of report:14-Aug-2013 03:23 PM Relevant Clinical Information:Data not supplied

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