

Healthcare costs and utilization before and after opioid overdose in Veterans Health Administration patients with opioid use disorder

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U.S. Department of Veterans Affairs
Veterans Health Administration
Health Services Research & Development Service



Disclaimer

- This work is under review and these results should be viewed as preliminary/in progress.
- Please do not distribute.
- Please contact vilija.joyce@va.gov for any updates.

Poll #1

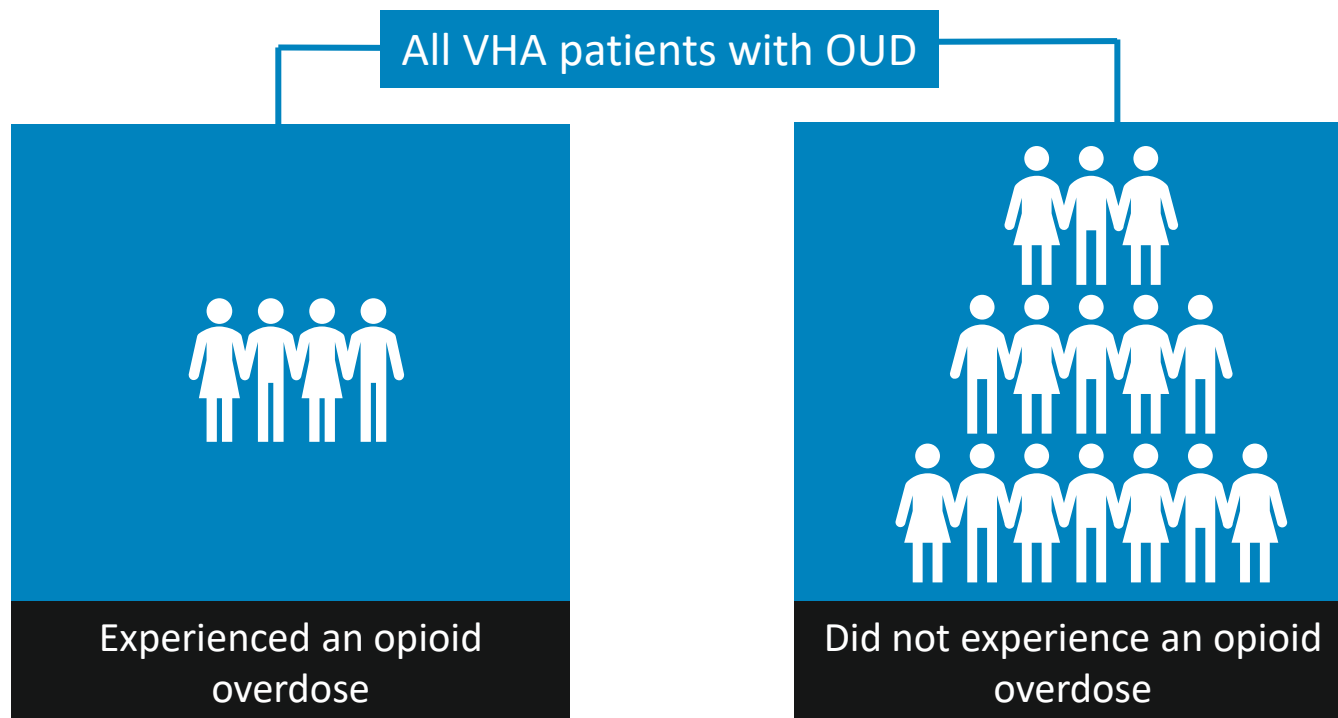
- What is your primary role at VA?
 - Investigator/clinician
 - Statistician, biostatistician
 - Data manager, analyst, programmer
 - Project manager/RA
 - Other

Introduction

- Opioid crisis is national public health emergency
 - 2020: 2.7m Americans w/ opioid use disorder (OUD)
 - 2021: 78,000 opioid-related overdose (OD) deaths
- Higher risk for OUD and subsequent overdose deaths among Veterans
- VHA → Largest single provider of substance use disorder treatment in the US

Objective

- Describe and compare healthcare cost and utilization trends



Poll #2

- How familiar are you with difference-in-differences study methods?
 - I understand the assumptions, have used difference-in-differences, and stay up to date on recent developments.
 - I've implemented a difference-in-differences model.
 - I've scanned the literature and I'm familiar with difference-in-differences.
 - I'm unfamiliar with difference-in-differences, but eager to learn more.

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Natural Experiments & Difference-in-Differences

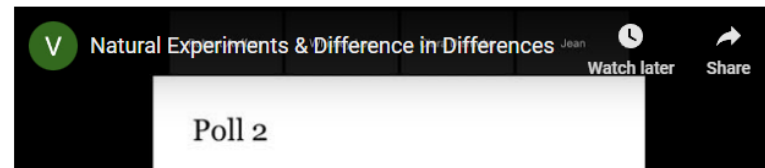
by Jean Yoon, PhD

Seminar date: 2/22/2023

Description: Natural experiments have been increasingly utilized by researchers in recent years. In this lecture, we will define what a natural experiment is and describe different types of natural experiments. We will also provide an overview of the difference-in-differences estimator and discuss how it can be used to evaluate treatment effects in natural experiments. Finally, we discuss potential threats to validity when evaluating natural experiments.

Target Audience: Researchers who would like an introduction to econometric methods for observational studies in health services research. Seminar material will assume knowledge of basic probability and statistics and familiarity with linear regression.

View archived session video:



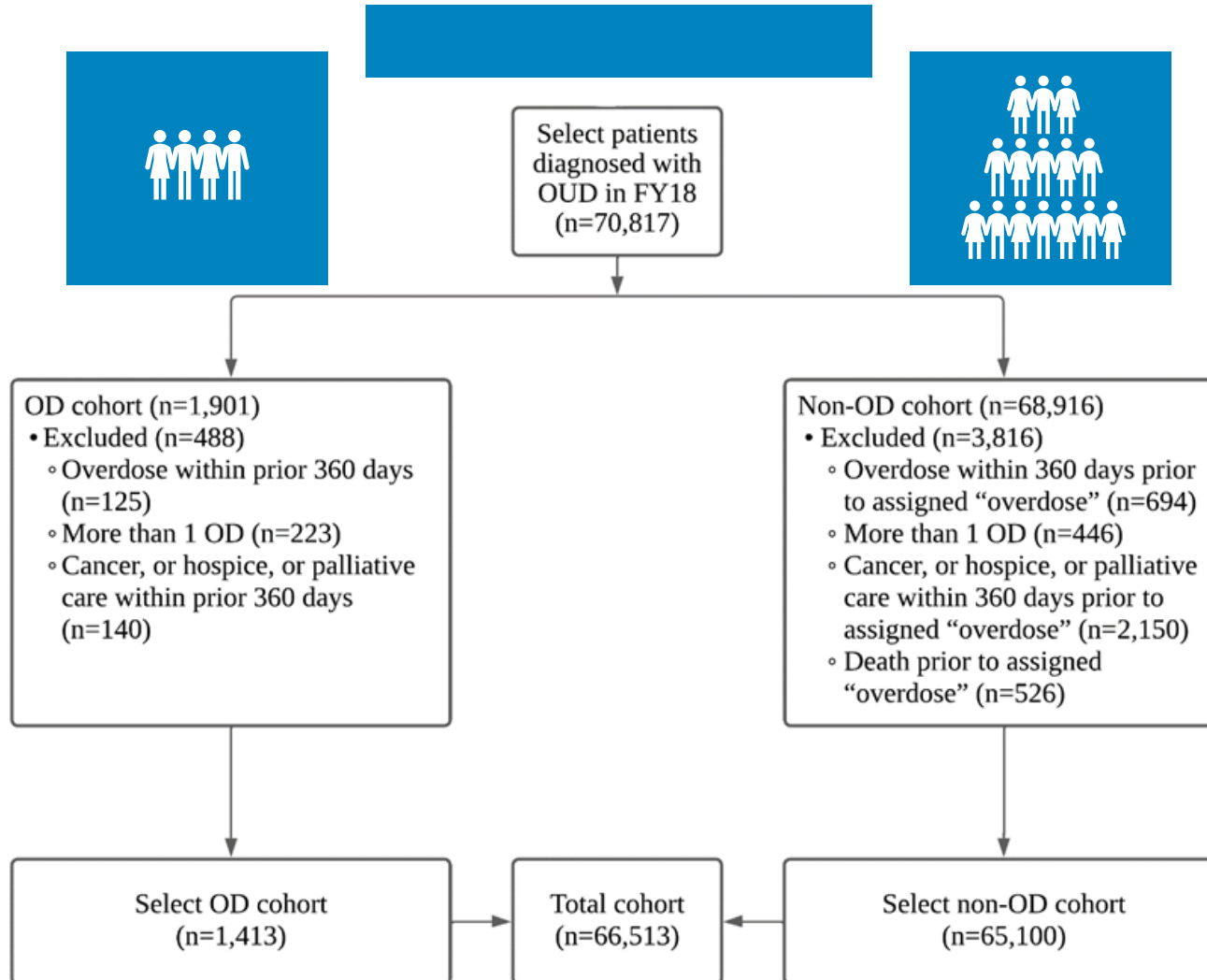
https://www.hsrd.research.va.gov/for_researchers/cyber_seminars/archives/video_archive.cfm?SessionID=5277

Methods

- Study Design and Data Source
 - Retrospective cohort study of administrative and clinical data
 - VHA Office of Mental Health and Suicide Prevention (OMHSP) Program Evaluation and Resource Center (PERC)
 - VHA Corporate Data Warehouse (CDW)
 - FY16-FY19

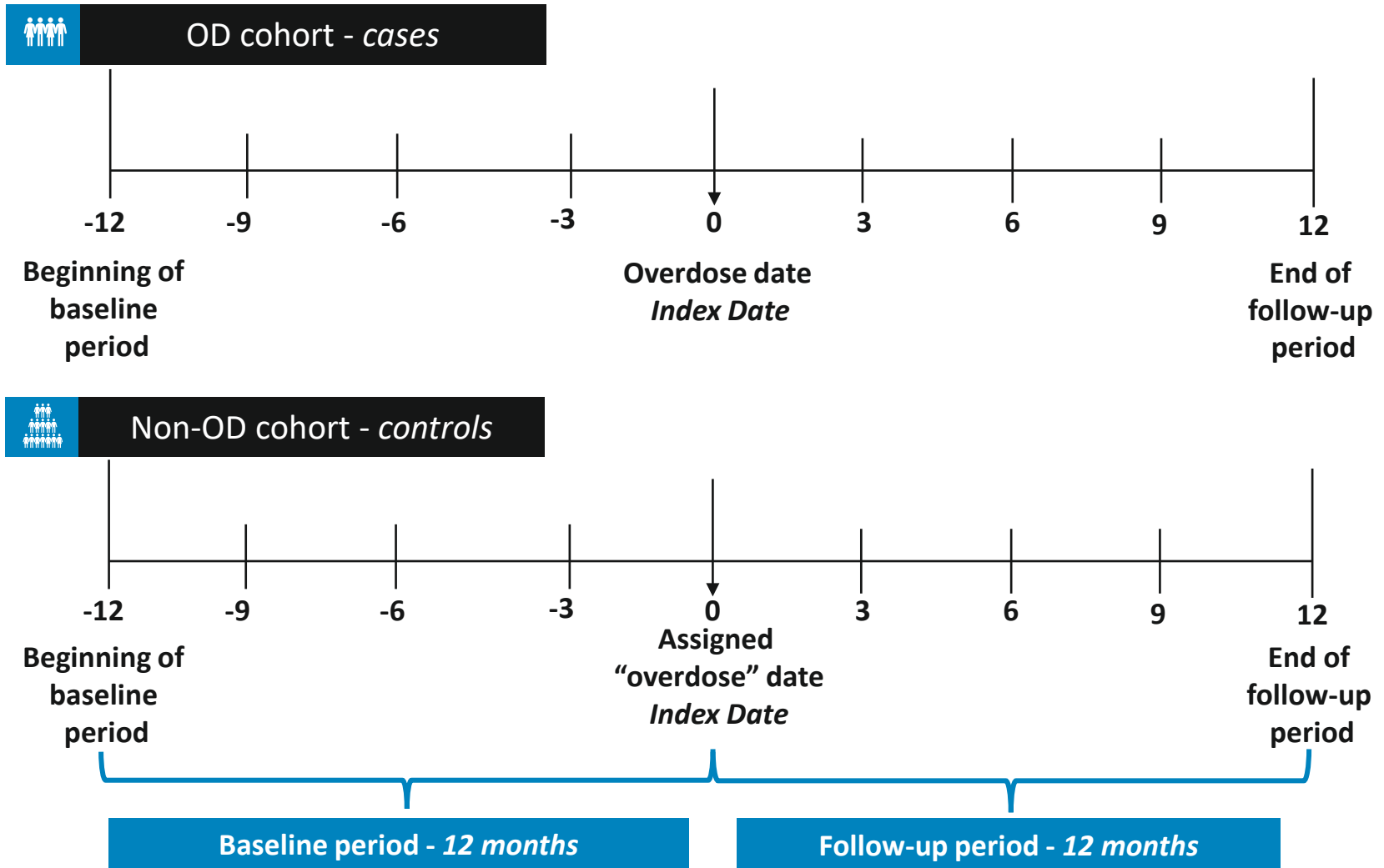
Methods

Figure 1. Flowchart showing patient inclusion and exclusion



Methods

Figure 2. Study timeline for OD cohort (cases) and non-OD cohort (controls)



Methods

- Primary outcomes
 - Healthcare costs and utilization following opioid overdose
- Cost data
 - Inpatient/outpatient
 - VA Managerial Cost Accounting System
 - Fee Basis/Program Integrity Tool (PIT)

Methods

- Baseline demographic/clinical characteristics
 - 360 days prior to index date
 - Age, sex, race...
 - Elixhauser comorbidities
 - Prescriptions (opioids, antidepressants...)
 - Risk Index for Overdose and Serious Opioid-Induced Respiratory Depression (RIOSORD)

Methods

- Healthcare costs
 - Total, inpatient, outpatient
 - Unadjusted analyses
 - Adjusted analyses
 - Difference-in-differences framework
 - Generalized estimating equation (GEE) models
 - Linear structure w/ autoregressive correlation
- Healthcare utilization
 - Length of stay, # inpatient admissions, # outpatient visits
 - Unadjusted analyses
 - Adjusted analyses
 - GEE models
 - Negative binomial distribution
 - Robust standard errors estimated by clustering on patient

Adjusted for baseline characteristics

- Age
- Sex
- Race/Ethnicity
- Marital status
- VA service-connected disability status
- Total number of Elixhauser comorbidities
- Morphine equivalent dose
- Nicotine use
- Rural status
- Chronic pulmonary disorder
- Chronic kidney disease
- Chronic hepatitis or cirrhosis
- Medication history 3 months prior to the index date

Methods

- Sensitivity analysis
 - Change in average monthly healthcare costs and utilization before and after the opioid overdose for those with *subsequent* overdoses
 - 1 additional overdose
 - 2+ overdoses

Methods

- If patient did not use care during a 30-day period, costs set to \$0.
- If patient died, subsequent period costs and utilization set to missing.
- Adjusted using Consumer Price Index for 2020
- SAS Enterprise Guide 8.2/Stata MP 17

Results: Cohort Characteristics

Table 1. Patient characteristics for FY18 Veterans Health Administration patients with opioid use disorder with and without opioid overdose (n=66,513)

Characteristic	OD Cohort (n=1,413)	Non-OD Cohort (n=65,100)	Standardized Difference
Sex, n (%)			
Female	108 (7.6)	5,007 (7.7)	0.002
Age at overdose, mean (SD)	51.6 (15.1)	52.4 (14.3)	0.053
Race, n (%)			
Black	249 (17.6)	12,140 (18.6)	0.027
White	1,086 (76.9)	48,941 (75.2)	0.039
Other	44 (3.1)	2,070 (3.2)	0.004
Ethnicity, Hispanic, n (%)	78 (5.5)	3,759 (5.8)	0.011
≥ 50% VA service-connected disability, n (%)	703 (49.9)	28,420 (43.9)	0.120

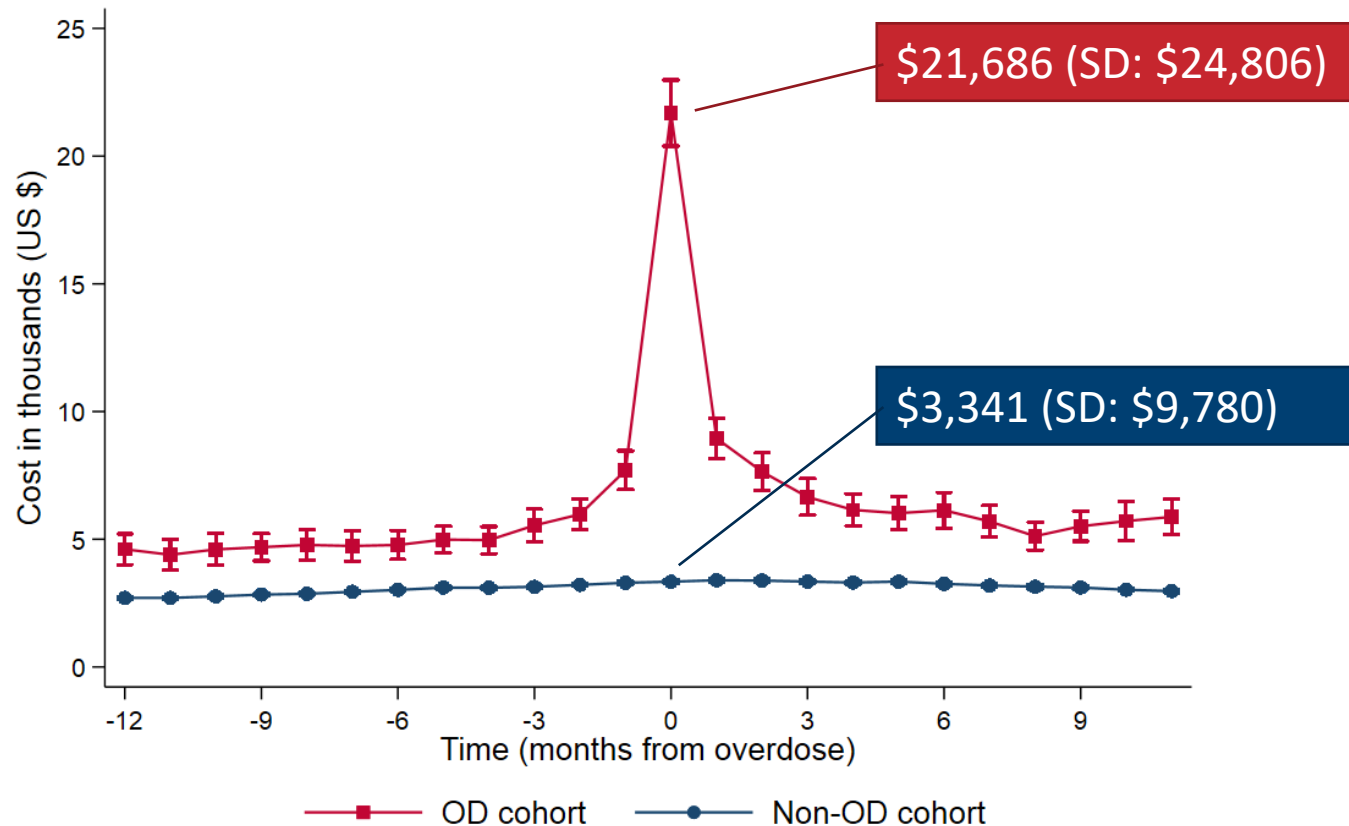
Results: Cohort Characteristics

Table 1. Select Patient Characteristics for FY18 Veterans with Opioid Use Disorder Cohort (n=66,513)

Characteristic	OD Cohort (n=1,413)	Non-OD Cohort (n=65,100)	Standardized Difference
RIOSORD Risk Index Score, mean (SD)	40.4 (16)	26 (16.1)	-0.895
Chronic pulmonary disease	506 (35.8)	12,929 (19.9)	0.362
Opioid use, by formulation			
Immediate-release only	392 (27.7)	22,193 (34.1)	0.138
Extended-release/long-acting only	47 (3.3)	1,684 (2.6)	0.044
Both	117 (8.3)	3,006 (4.6)	0.150
Average total daily morphine milligram equivalents, n (%)			
<50	1,225 (86.7)	59,872 (92)	0.171
50 to <100	97 (6.9)	3,038 (4.7)	0.094
>= 100	91 (6.4)	2,190 (3.4)	0.143
Select Non-Opioid Drugs, n (%)			
Antidepressant	823 (58.2)	33,469 (51.4)	0.138

Results: Unadjusted trend analyses

Figure 3a. Unadjusted average monthly total healthcare costs 12 months before and after overdose, by cohort*



* Both the OD and non-OD cohorts' average monthly costs include the 95% confidence intervals.

Results: Unadjusted trend analyses

Figure 3b. Unadjusted average monthly **inpatient** healthcare costs 12 months before and after overdose, by cohort*

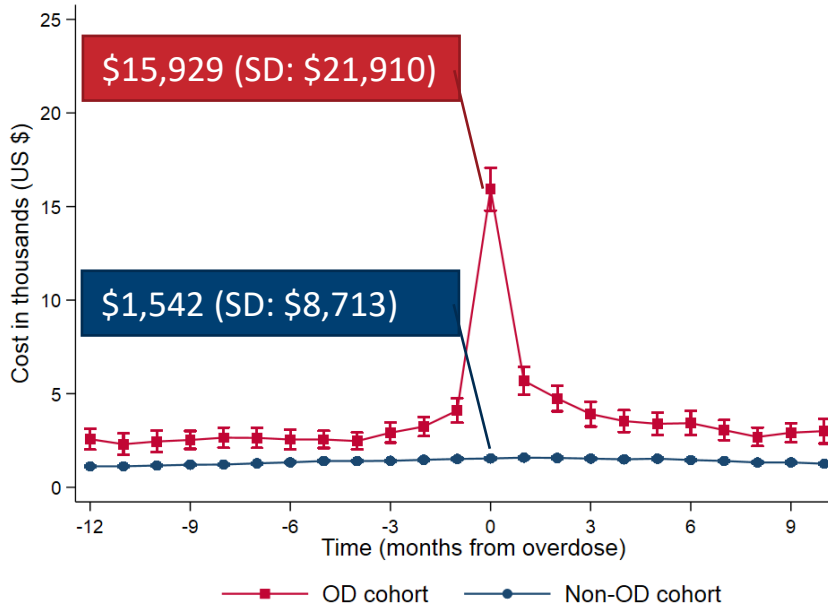
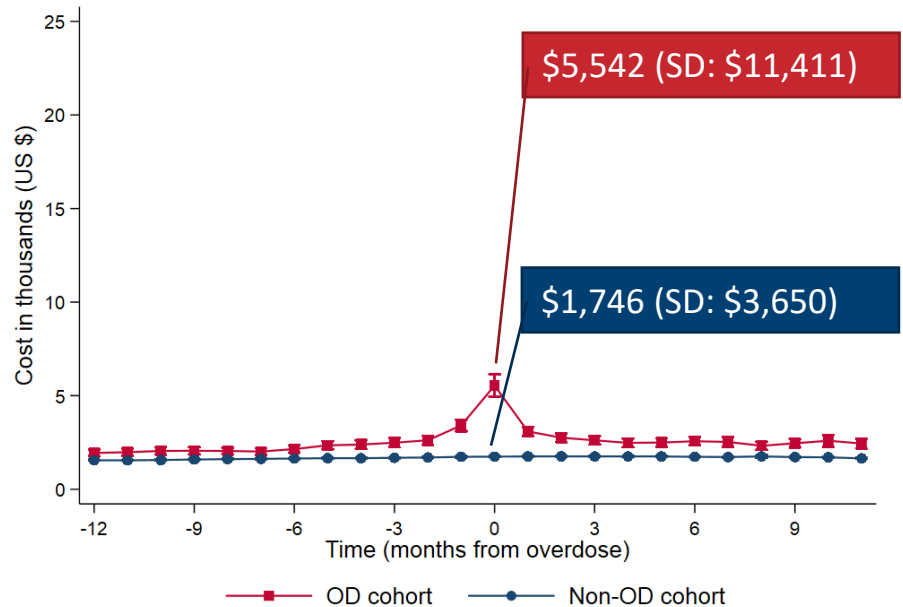


Figure 3c. Unadjusted average monthly **outpatient** healthcare costs 12 months before and after overdose, by cohort*



* Both the OD and non-OD cohorts' average monthly costs include the 95% confidence intervals.

Results: Adjusted cost analyses

Table 2. Marginal adjusted costs and utilizations of the overdose and the non-overdose groups at 30 days before and up to 60 days after the index date (2020 US dollars).

Types of costs	-30 to -1 days	0-30 days	31-60 days
All costs (\$), mean (95% CI)	2908 (2171, 3645)***	16890 (15611, 18169)***	3970 (3218, 4722)***
Inpatient categories (\$), mean (95% CI)			
Total inpatient costs	1686 (1046, 2325)***	13515 (12378, 14652)***	3118 (2399, 3837)***
Med/Surg	1215 (694, 1736)***	7522 (6594, 8450)***	589 (188, 989)**
Psych/Mental health	320 (99, 541)**	2884 (2437, 3330)***	536 (253, 819)***
Substance use treatment	17 (-79, 113)	671 (482, 859)***	242 (110, 374)***
Mental health residential rehabilitation treatment program	-242 (-341, -143)***	230 (52, 407)*	681 (424, 938)***
Other	114 (-98, 325)	1098 (673, 1524)***	766 (385, 1148)***

* <0.05; ** <0.01; *** < 0.001

Results: Adjusted cost analyses

Table 2. Marginal adjusted costs and utilizations of the overdose and the non-overdose groups at 30 days before and up to 60 days after the index date (2020 US dollars).

Types of costs	-30 to -1 days	0-30 days	31-60 days
Outpatient categories (\$), mean (95% CI)			
Total outpatient costs	1116 (815, 1418)***	3247 (2648, 3845)***	775 (535, 1015)***
Med/Surg	402 (284, 520)***	756 (669, 842)***	141 (76, 205)***
Psych/Mental health	61 (2, 120)*	224 (173, 274)***	52 (5, 100)*
Substance use treatment	20 (-16, 56)	135 (87, 182)***	146 (94, 197)***
Pharmacy	-35 (-143, 72)	-58 (-115, -0.1)*	-29 (-100, 42)
Mental health residential rehabilitation treatment program	10 (3, 17)**	28 (15, 40)***	20 (9, 31)***
Other	354 (242, 466)***	1070 (545, 1595)***	221 (131, 311)***

* <0.05; ** <0.01; *** < 0.001

Results: Adjusted utilization analyses

Table 2. Marginal adjusted costs and utilizations of the overdose and the non-overdose groups at 30 days before and up to 60 days after the index date (2020 US dollars).

Resource utilization	-30 to -1 days	0-30 days	31-60 days
Length of stay (days), mean (95% CI)	0.45 (0.23, 0.68)***	6.15 (5.33, 6.97)***	2.26 (1.74, 2.77)***
Inpatient admissions (No.), mean (95% CI)	0.10 (0.07, 0.13)***	1.01 (0.93, 1.10)***	0.19 (0.15, 0.23)***
Outpatient visits (No.), mean (95% CI)	0.23 (0.01, 0.45)*	1.59 (1.34, 1.84)***	0.78 (0.52, 1.03)***

* <0.05; ** <0.01; *** < 0.001

Results: Sensitivity Analysis

Table 3. Pre and post-event outcomes for those with subsequent overdoses among the opioid overdose cohort (2020 US dollars)

	Two or more additional opioid overdose after the index date			
Type of costs / expenditures, mean (95% CI)	Before the index event (n = 43)	On or after the index event (n = 43)	difference	p-value
Total costs (\$)	6844 (4887, 9000)	12802 (9693, 15,912)	5958 (2888, 8828)	<0.001
Total inpatient costs (\$)	4063 (2477, 5649)	8474 (6075, 10,873)	4411 (1752, 7070)	<0.001
Total outpatient costs (\$)	2406 (1801, 3012)	3930 (2999, 4860)	1523 (700, 2347)	<0.001
Length of stay (days)	2.22 (1.10, 3.34)	3.24 (2.07, 4.42)	1.03 (-0.59, 2.64)	0.208
Inpatient admission (n)	0.40 (0.23, 0.57)	0.68 (0.49, 0.87)	0.28 (0.08, 0.49)	0.002
Outpatient visits (n)	4.85 (3.85, 5.86)	5.43 (4.36, 6.51)	0.58 (0.34, 1.50)	0.217

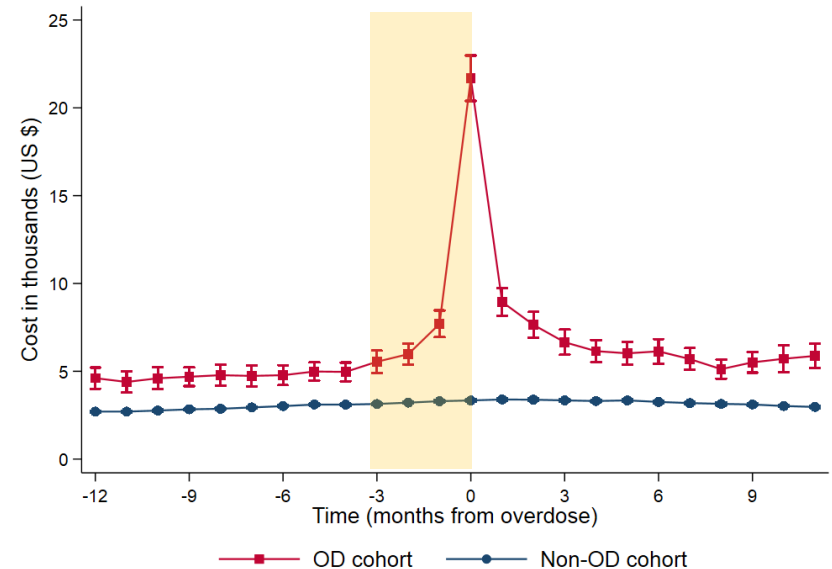
* Wilcoxon signed rank tests were used for non-parametric paired data.

CI=confidence interval

Limitations

- Violation of difference-in-differences parallel trends assumption
 - Estimates biased upwards
- Study was limited to patients with OUD who had an overdose event
 - Underreporting opioid overdoses?

Figure 3a. Unadjusted average monthly total healthcare costs 12 months before and after overdose, by cohort*



Conclusions

- Total overall cost of opioid overdose is substantial
 - First month following overdose...
 - Marginal increase of \$16,890
 - Economic burden to VHA? \$23.9 million
- Driven mostly by inpatient expenditures
- Policy reform to reduce barriers to treatment and improve retention among those treated with medications for opioid use disorder (MOUD)

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 - PI: Keith Humphreys, PhD
 - Original PI: Douglas K. Owens, MD, MS

Questions?

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