

Supplementary Online Content

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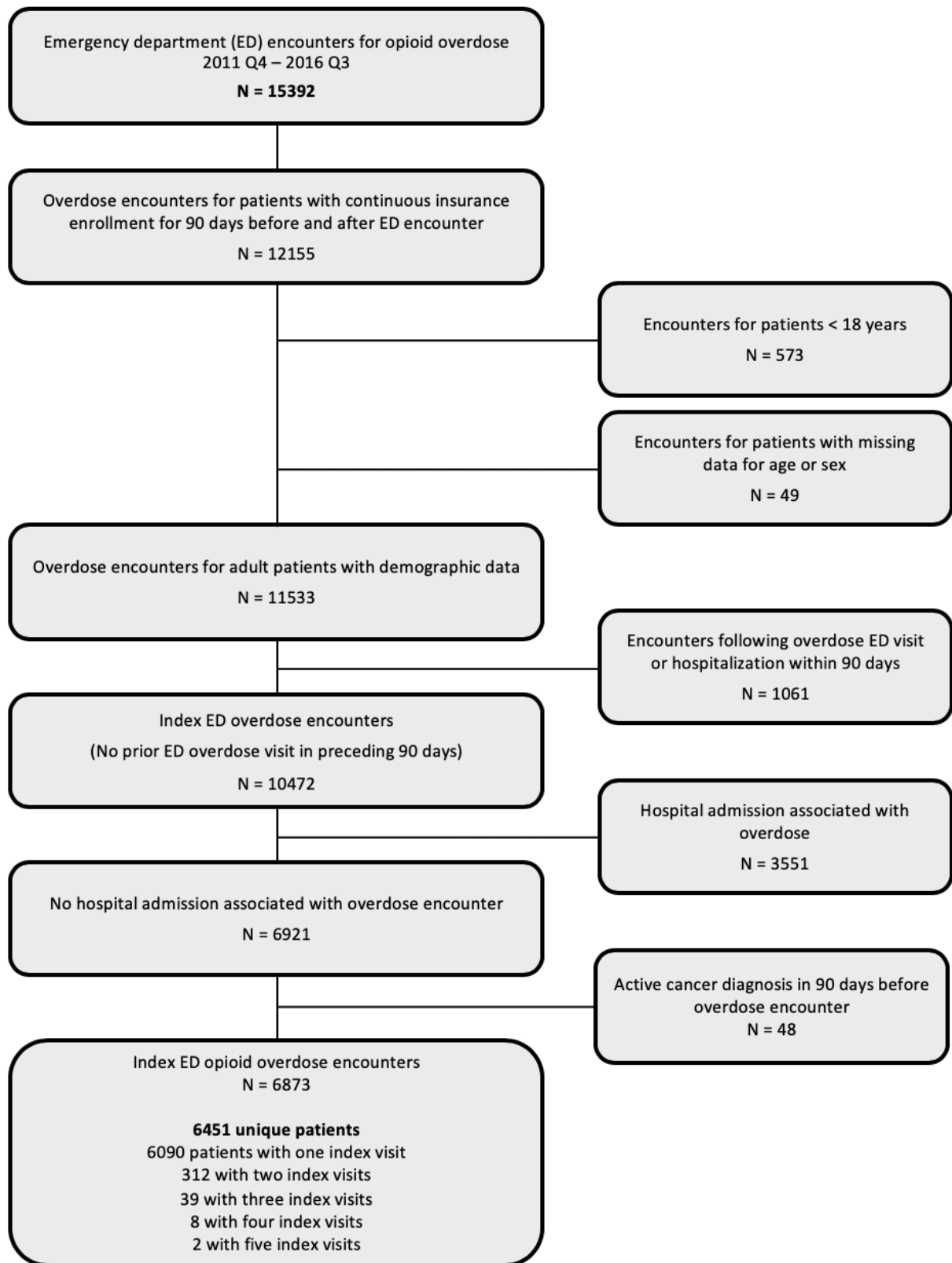
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This supplementary material has been provided by the authors to give readers additional information about their work.

eFigure 1. Flowchart for Selection of Patient Cohort



eTable 1 ICD-9-CM, ICD-10, CPT, and AHFS Codes for Selection of Patient Cohort and Patient Characteristics

	ICD-9-CM ^a Diagnosis Codes	ICD-10 ^a Diagnosis Codes	CPT Codes	AHFS Pharmacologic-Therapeutic Codes
Opioid Overdose	Heroin: 965.01, E850.0 Prescription: 965.00, 965.02, 965.09, E.850.1, E.850.2	Heroin: T40.1X Prescription: T40.0X, T40.2-4X, T40.6X		
Emergency Department Encounters			99281, 99282, 99283, 99284, 99285	
Cancer (Malignant Neoplasm)^b Diagnosis	140.X – 208.X 209.0 – 209.3 V10.X	C00X – C97X		
Anxiety Diagnosis	293.84, 300.00, 300.01, 300.02, 300.09, 300.10, 300.20, 300.21, 300.22, 300.23, 300.29, 300.3, 300.5, 300.89, 300.9, 308.0, 308.1, 308.2, 308.3, 308.4, 308.9, 309.81, 313.0, 313.1, 313.21, 313.22, 313.3, 313.82, 313.83	F06.4, F40.00, F40.01, F40.02, F40.10, F40.11, F40.210, F40.218, F40.220, F40.228, F40.230, F40.231, F40.232, F40.233, F40.240, F40.241, F40.242, F40.243, F40.248, F40.290, F40.291, F40.298, F40.8, F40.9, F41.0, F41.1, F41.3, F41.8, F41.9, F42, F42.2, F42.3, F42.4, F42.8, F42.9, F43.0, F43.10, F43.11, F43.12, F44.9, F45.8, F48.8, F48.9, F93.8, F99, R45.2, R45.5, R45.6, R45.7		
Depression Diagnosis	296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 300.4, 311, V79.0	F32.0, F32.1, F32.2, F32.3, F32.4, F32.5, F32.89, F32.9, F33.0, F33.1, F33.2, F33.3, F33.8, F33.40, F33.41, F33.42, F33.9, F34.1		
Prescription Opioid Full Agonist				280808
Benzodiazepine				281208, 282408

^a ICD-9-CM diagnosis codes are used for any claim prior to October 1 2015. ICD-10 diagnosis codes are used for claims on that date or after.

^b Benign neoplasms or neoplasms of uncertain behavior were excluded

eTable 2. National Drug Codes for Medications for Opioid Use Disorder

	National Drug Codes (NDC)
Buprenorphine and Buprenorphine-Naloxone	54017613, 54017713, 54018813, 54018913, 74201201, 74201232, 93360021, 93360040, 93360121, 93360140, 93360221, 93360240, 93360321, 93360340, 93537856, 93537956, 93572056, 93572156, 149075701, 228315303, 228315403, 228315473, 228315503, 228315567, 228315573, 228315603, 378092393, 378092493, 406192303, 406192403, 406802003, 409201203, 409201232, 490005100, 490005130, 490005160, 490005190, 12496010001, 12496010002, 12496010005, 12496030001, 12496030002, 12496030005, 12496075701, 12496075705, 12496120201, 12496120203, 12496120401, 12496120403, 12496120801, 12496120803, 12496121201, 12496121203, 12496127802, 12496128302, 12496130602, 12496131002, 16590066605, 16590066630, 16590066705, 16590066730, 16590066790, 21695051510, 23490927003, 23490927006, 23490927009, 35356000407, 35356000430, 35356055530, 35356055630, 35356060504, 35356060704, 38779088800, 38779088801, 38779088803, 38779088805, 38779088806, 38779088809, 40042001001, 42023017901, 42023017905, 42291017430, 42291017530, 42858035340, 42858049340, 42858050103, 42858050203, 42858058640, 42858075040, 42858083940, 43063018407, 43063018430, 43063066706, 43063075306, 49452129201, 49452129202, 49452129203, 49452825301, 49452825302, 49452825303, 49999039507, 49999039515, 49999039530, 49999063830, 49999063930, 50268014411, 50268014415, 50268014511, 50268014515, 50383028793, 50383029493, 50383092493, 50383093093, 51552076501, 51552076502, 51552076505, 51552076506, 51552076509, 51552076510, 51552076550, 51927101200, 52959030430, 52959074930, 53217013830, 54123011430, 54123090730, 54123091430, 54123092930, 54123095730, 54123098630, 54569141600, 54569141601, 54569549600, 54569573900, 54569573901, 54569573902, 54569632500, 54569632600, 54569639900, 54569640800, 54569657800, 54868570700, 54868570701, 54868570702, 54868570703, 54868570704, 54868575000, 55045378403, 55390010010, 55700014730, 55700018430, 55700030230, 55700030330, 55700057904, 58284010014, 59011075004, 59011075104, 59011075204, 59011075704, 59011075804, 59385001201, 59385001230, 59385001401, 59385001430, 59385001601, 59385001630, 59385002101, 59385002160, 59385002201, 59385002260, 59385002301, 59385002360, 59385002401, 59385002460, 59385002501, 59385002560, 59385002601, 59385002660, 59385002701, 59385002760, 60429058611, 60429058630, 60429058633, 60429058711, 60429058730, 60429058733, 62756045983, 62756046083, 62756096983, 62756097083, 62991158301, 62991158302, 62991158303, 62991158304, 62991158306, 62991158307, 62991158308, 63275992201, 63275992202, 63275992203, 63275992204, 63275992205, 63275992207, 63370090506, 63370090509, 63370090510, 63370090515, 63459030042, 63481016101, 63481016160, 63481020701, 63481020760, 63481034801, 63481034860, 63481051901, 63481051960, 63481068501, 63481068560, 63481082001, 63481082060, 63481095201, 63481095260, 63629402801, 63629403401, 63629403402, 63629403403, 63629409201, 63874108403, 63874108503, 63874117303, 65162041503, 65162041603, 65757030001, 65757030202, 66336001630, 68071138003, 68071151003, 68258299103, 68258299903, 68308020230, 68308020830, 35356060604, 53217024630, 55887031204, 55887031215, 63874117403, 66336001530, 406192309, 406192409, 406800503, 50090157100, 55700056804, 60846097003, 60846097103, 62175045232, 62175045832, 62756045964, 62756046064, 62756096964, 62756097064, 63629409202, 63629507401, 63629712501, 63629712502, 63629712503, 63629712504, 63629712505, 63629712506, 63629712507, 63629712601, 63629712602, 63629712603, 63629712604, 63629712605, 63629712606, 63629712607, 63629712608, 63629727001, 63629727002, 64725093003, 64725093004, 64725192403, 64725192404, 65162041509, 65162041609, 71335035301, 71335035302, 71335035303, 71335035304, 71335035305, 71335035306, 71335035307, 76519117000, 76519117001, 76519117002, 76519117003, 76519117004

Naltrexone	43063059115, 47335032683, 47335032688, 50436010501, 51224020630, 51224020650, 51285027501, 51285027502, 52152010502, 52152010504, 52152010530, 54868557400, 63459030042, 65694010003, 65694010010, 65757030001, 65757030202, 68084029111, 68084029121, 68094085362, 68115068030, 56001122, 56001130, 56001170, 56007950, 56008050, 185003901, 185003930, 406009201, 406009203, 406117001, 406117003, 555090201, 555090202, 16729008101, 16729008110, 42291063230
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eTable 3 CPT, HCPCS, ICD-9-CM, and ICD-10-CM Codes for Treatment Encounters

Current Procedure Terminology (CPT) Codes	Healthcare Common Procedure Coding System (HCPCS) Codes	ICD-9-CM Diagnosis Codes (claim prior to October 1 2015)	ICD-10-CM Diagnosis Codes (claim on or after October 1 2015)
<p>Office or Outpatient Visit: 99201-99205 99211-99215</p> <p>Psychiatric Diagnosis: 90791-90792</p> <p>Psychotherapy Services: 90832-90839 90853 90863 90875-90876 90801-90815 90824 90862</p> <p>Screening, Brief Intervention, and Referral to Treatment (SBIRT): 99408-99409</p>	<p>Drug, Alcohol, and Behavioral Health Services (Outpatient and Inpatient): H0001, H0002 H0004-H0019 H0031-H0040 G0396-G0397</p> <p>Mental Health Services NOS: H0046-H0047</p> <p>Halfway House / Treatment Program: H2034-H2036</p> <p>Clinic Visit / Case Management: T1015-T1017 T1001</p> <p>MOUD Codes: J0571-J0575 J1230, J2315</p> <p>Excluded <i>Methadone maintenance therapy:</i> <i>H0020</i></p>	<p>304.00-304.03 305.50-305.53 304.70-304.73 965.00-965.02, 965.09 E85.00-E85.02 E93.50-E93.51</p>	<p>Opioid use, abuse, dependence: F1190, F11920-F11922, F11929 F1193, F1194, F11950-F11951, F11959, F11981, F11982, F11988 F1199, F1110, F11120-F11122, F1129, F1114, F11150-F11151, F11159, F11181, F11182, F11188, F1119, F1120, F11220-F11222, F11229, F1123, F1124, F11250, F11251, F11259, F11281, F11282, F11288, F1129</p> <p>Poisoning: T400X1*, T400X2*, T400X3*, T400X4* T401X1*, T401X2*, T401X3*, T401X4* T403X1*, T403X2*, T403X3*, T403X4* T402X1*, T402X2*, T402X3*, T402X4* T404X1*, T404X2*, T404X3*, T404X4*</p>

			T40601*, T40602*, T40603*, T40604* T40605*, T40691*, T40692*, T40693*, T40694*, T40695*, T403X5* * Position can include A, D, or S
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eTable 4 Adjusted probability of follow-up treatment after opioid overdose for patients treated prior to overdose

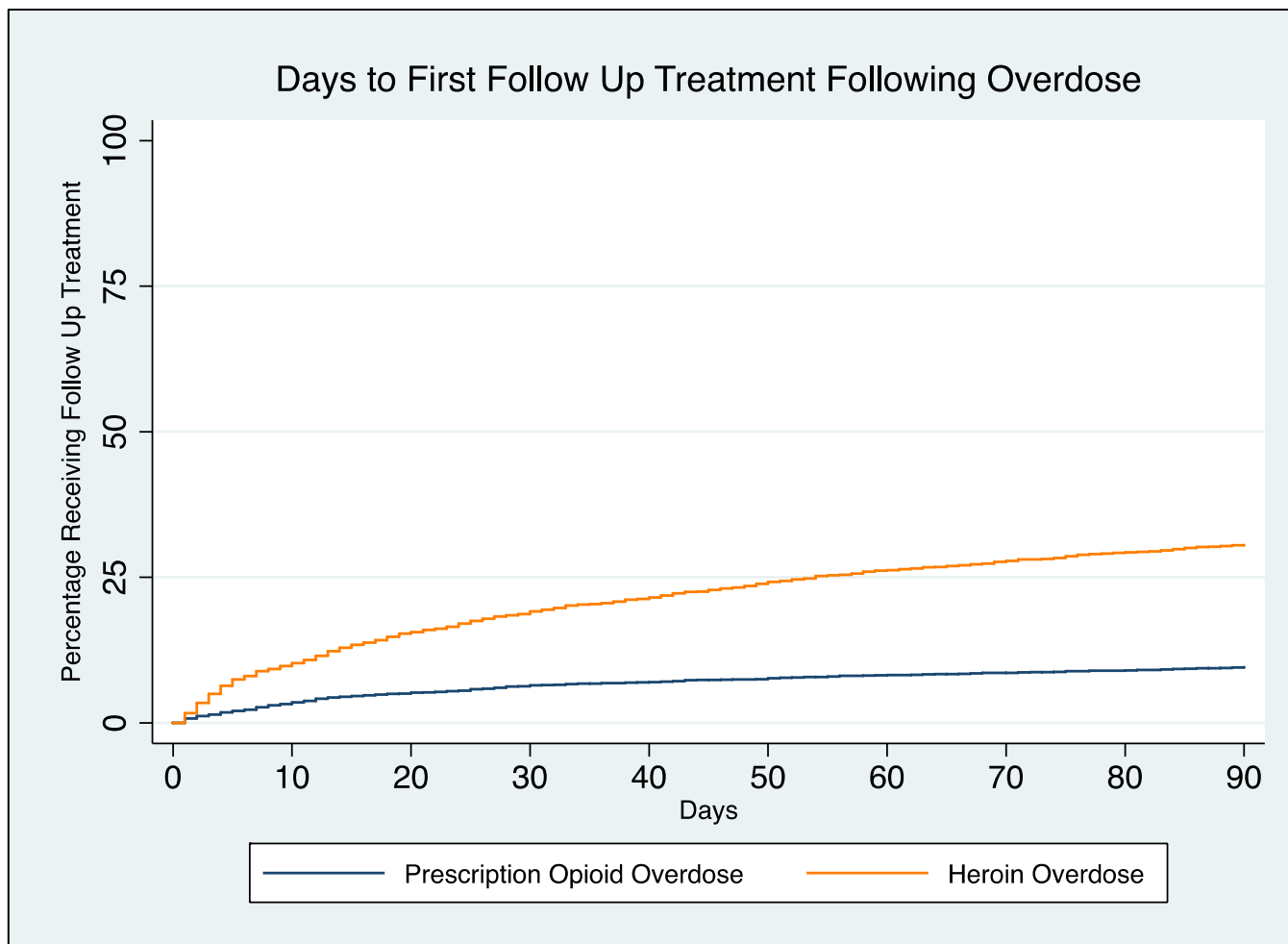
		Average Adjusted Prediction (95% CI), %	P
Overdose Type			
	Prescription	64.2 (57.5 to 70.7)	--
	Heroin	61.3 (56.0 to 66.5)	.55
Age (years), mean (SD)		62.5 (59.0 to 66.1)	.21
Sex			
	Male	62.2 (57.5 to 70.0)	--
	Female	62.7 (57.4 to 68.2)	.89
Race/Ethnicity			
	White	62.8 (58.7 to 66.9)	--
	Black	75.9 (63.4 to 88.4)	.06
	Hispanic	61.3 (47.3 to 75.3)	.84
	Asian	59.6 (13.8 to 105.3)	.89
	Unknown	51.7 (39.1 to 64.1)	.10
Year			
	2011 Q4	48.3 (22.2 to 74.5)	--
	2012	66.0 (56.1 to 75.8)	.22
	2013	66.9 (58.9 to 75.8)	.19
	2014	60.9 (52.8 to 69.0)	.37
	2015	54.8 (46.9 to 62.7)	.65
	2016 Q1-3	66.4 (59.2 to 73.6)	.19
Region			
	Northeast	73.3 (64.7 to 82.0)	
	South	58.3 (51.9 to 64.1)	.007
	Midwest	67.3 (61.0 to 73.6)	.26
	West	53.2 (44.4 to 62.0)	.002
Anxiety treatment, 90 d prior to overdose			
	No	62.3 (57.6 to 67.1)	
	Yes	62.6 (56.8 to 68.5)	.94
Depression treatment, 90 d prior to overdose			
	No	63.3 (59.0 to 67.6)	
	Yes	60.7 (54.1 to 67.2)	.53
Prescription opioid claim, 90 d prior to overdose			
	No	65.1 (60.4 to 69.8)	
	Yes	56.9 (48.9 to 64.8)	.11
Benzodiazepine claim, 90 d prior to overdose			
	No	60.1 (55.4 to 64.7)	
	Yes	66.7 (60.7 to 72.6)	.10

eTable 5 Adjusted probability of MOUD treatment after opioid overdose, stratified by treatment status prior to overdose

		No MOUD in 90 days prior to overdose, n = 6131		MOUD in 90 days prior to overdose, n = 320	
		Average Adjusted Prediction (95% CI), %	<i>P</i>	Average Adjusted Prediction (95% CI), %	<i>P</i>
Overdose Type					
	Prescription	3.2 (2.6 to 3.8)	--	55.8 (45.6 to 66.0)	--
	Heroin	6.8 (5.6 to 8.1)	< .001	53.5 (46.2 to 60.9)	.75
Age (years), at mean		3.6 (3.0 to 4.1)	< .001	54.4 (49.2 to 59.6)	.22
Sex					
	Male	5.1 (4.5 to 5.7)	--	54.6 (47.9 to 61.3)	--
	Female	3.9 (3.2 to 4.6)	.03	54.0 (45.0 to 62.9)	.92
Race/Ethnicity					
	White	4.8 (4.3 to 5.3)	--	53.2 (47.1 to 59.3)	--
	Black	3.0 (1.6 to 4.4)	.03	71.8 (50.8 to 92.7)	.10
	Hispanic	4.1 (2.3 to 5.9)	.47	70.4 (50.8 to 90.0)	.10
	Asian	5.9 (-.19 to 12.1)	.71	62.0 (2.6 to 126.7)	.79
	Unknown	4.3 (2.6 to 6.0)	.60	40.5 (20.7 to 60.1)	.23
Year					
	2011 Q4	6.0 (2.9 to 9.2)	--	27.3 (-3.9 to 58.6)	--
	2012	4.2 (3.0 to 5.5)	.29	48.8 (34.6 to 63.0)	.22
	2013	6.4 (4.9 to 7.8)	.85	61.7 (50.4 to 72.9)	.05
	2014	3.4 (2.4 to 4.4)	.12	58.1 (45.1 to 71.0)	.07
	2015	4.4 (3.4 to 5.5)	.35	50.4 (37.8 to 63.1)	.18
	2016 Q1-3	4.4 (3.3 to 5.5)	.33	54.2 (42.6 to 65.9)	.11
Region					
	Northeast	4.4 (3.0 to 5.9)	--	55.3 (40.0 to 70.7)	--
	South	5.1 (4.2 to 6.0)	.46	51.9 (43.4 to 60.4)	.70
	Midwest	3.9 (3.0 to 4.8)	.52	58.7 (48.7 to 68.8)	.72
	West	4.8 (3.6 to 5.9)	.75	52.6 (40.0 to 65.4)	.79
Anxiety treatment, 90 d prior to overdose					
	No	4.3 (3.7 to 4.9)	--	54.5 (47.3 to 61.7)	--
	Yes	5.4 (4.2 to 6.6)	.13	54.1 (45.2 to 63.0)	.95
Depression treatment, 90 d prior to overdose					
	No	4.4 (3.8 to 5.0)	--	59.0 (52.7 to 65.3)	--
	Yes	5.0 (3.8 to 6.3)	.39	42.9 (32.5 to 53.2)	.01
Prescription opioid claim, 90 d prior to overdose					
	No	4.3 (3.6 to 4.9)	--	57.0 (50.4 to 63.4)	--
	Yes	5.1 (4.0 to 6.2)	.22	47.3 (35.2 to 59.3)	.20
Benzodiazepine claim, 90 d prior to overdose					
	No	4.0 (3.4 to 4.6)	--	53.9 (46.8 to 61.0)	--
	Yes	6.2 (2.9 to 7.5)	.003	55.0 (46.3 to 63.8)	.86
Outpatient OUD Treatment, 90 d prior to overdose					
	No	4.0 (3.5 to 4.5)	--	50.9 (42.6 to 59.1)	--
	Yes	10.1 (7.5 to 12.7)	< .001	57.2 (50.0 to 64.5)	.27

eFigure 2

Kaplan-Meier Failure Curve for Days to First Follow Up Treatment Following Index ED Overdose^a



^aFollow up treatment includes claim for OUD treatment encounter or pharmacy claim for MOUD

eTable 6 Adjusted probability of follow-up treatment after opioid overdose, excluding patients without known claims beyond 90-day follow-up period (sensitivity analysis to address potential mortality during follow-up period).

		No MOUD in 90 days prior to overdose, n = 6131		MOUD in 90 days prior to overdose, n = 320	
		Average Adjusted Prediction (95% CI), %	P	Average Adjusted Prediction (95% CI), %	P
Overdose Type					
	Prescription	8.5 (7.5 to 9.4)	--	64.2 (57.5 to 70.1)	--
	Heroin	18.0 (15.8 to 20.2)	< .001	62.2 (56.8 to 67.6)	.69
Age (years), mean (SD)		10.1 (9.3 to 11.0)	< .001	63.1 (59.5 to 66.7)	.22
Sex					
	Male	12.4 (11.3 to 13.7)	--	62.5 (57.7 to 67.3)	--
	Female	10.4 (9.2 to 11.5)	.01	63.7 (58.2 to 69.1)	.76
Race/Ethnicity					
	White	12.5 (11.6 to 13.4)	--	63.3 (59.2 to 67.4)	--
	Black	6.3 (4.1 to 8.6)	< 0.001	75.8 (63.2 to 88.4)	.06
	Hispanic	9.1 (6.8 to 11.4)	.02	60.8 (46.6 to 74.9)	.73
	Asian	11.1 (3.2 to 19.1)	.75	60.0 (14.4 to 105.6)	.89
	Unknown	10.3 (7.6 to 13.1)	.15	53.0 (40.1 to 65.9)	.14
Year					
	2011 Q4	12.4 (8.0 to 16.7)	--	48.2 (22.0 to 74.2)	--
	2012	9.5 (7.7 to 11.4)	.24	66.2 (56.3 to 76.0)	.21
	2013	11.7 (9.7 to 13.6)	.77	66.6 (58.6 to 74.7)	.19
	2014	10.2 (8.4 to 11.9)	.36	61.0 (52.9 to 69.1)	.36
	2015	13.5 (11.7 to 15.4)	.62	56.7 (48.7 to 64.7)	.54
	2016 Q1-3	11.9 (10.1 to 13.8)	.86	67.0 (59.7 to 74.2)	.17
Region					
	Northeast	14.3 (11.9 to 16.8)	--	73.2 (64.5 to 81.8)	--
	South	10.7 (9.5 to 11.8)	.02	58.9 (52.3 to 65.4)	.01
	Midwest	11.4 (9.9 to 13.0)	.06	68.3 (62.0 to 74.7)	.37
	West	11.6 (9.8 to 13.4)	.09	53.5 (44.6 to 62.3)	.002
Anxiety treatment, 90 d prior to overdose					
	No	10.7 (9.8 to 11.6)	--	63.1 (58.2 to 67.9)	--
	Yes	14.0 (11.9 to 16.1)	.01	63.0 (57.1 to 68.9)	.98
Depression treatment, 90 d prior to overdose					
	No	11.4 (10.5 to 12.3)	--	63.9 (59.6 to 68.3)	--
	Yes	11.8 (9.9 to 13.8)	.70	61.0 (57.0 to 68.9)	.49
Prescription opioid claim, 90 d prior to overdose					
	No	11.5 (10.4 to 12.7)	--	65.8 (61.0 to 70.6)	--
	Yes	11.4 (10.0 to 12.9)	.93	57.3 (49.4 to 65.3)	.11
Benzodiazepine claim, 90 d prior to overdose					
	No	10.8 (9.8 to 11.7)	--	60.5 (55.8 to 65.1)	--
	Yes	13.3 (11.5 to 15.1)	.02	67.4 (61.4 to 73.4)	.08

eTable7 Index Opioid Overdoses by specific ICD-9 or ICD-10 Diagnosis Code, with number and frequency for each diagnosis code

Diagnosis Code	Definition	Number	Frequency (%)
965.00	Poisoning by opium (unspecified)	1135	17.59
965.01	Poisoning by heroin	1209	18.74
965.02	Poisoning by methadone	139	2.15
965.09	Poisoning by other opiates and related narcotics	2243	34.77
E.850.0	Accidental poisoning by heroin	4	0.06
E.850.1	Accidental poisoning by methadone	2	0.03
E.850.2	Accidental poisoning by other opiates and related narcotics	21	0.33
<i>ICD-10 [Starting October 1 2015]</i>			
T400X1A	Poisoning by opium, accidental (unintentional), initial encounter	28	0.43
T400X2A	Poisoning by opium, intentional self-harm, initial encounter	2	0.03
T400X4A	Poisoning by opium, undetermined, initial encounter	3	0.05
T401X1A	Poisoning by heroin, accidental (unintentional), initial encounter	535	8.29
T401X2A	Poisoning by heroin, intentional self-harm, initial encounter	38	0.59
T401X4A	Poisoning by heroin, undetermined, initial encounter	51	0.79
T402X1A	Poisoning by other opioids, accidental (unintentional), initial encounter	579	8.98
T402X1D	Poisoning by other opioids, accidental (unintentional), subsequent encounter	2	0.03
T402X1S	Poisoning by other opioids, accidental (unintentional), sequelae	1	0.02
T402X2A	Poisoning by other opioids, intentional self-harm, initial encounter	160	2.48
T402X4A	Poisoning by other opioids, undetermined, initial encounter	62	0.96
T403X1A	Poisoning by methadone, accidental (unintentional), initial encounter	40	0.62
T403X2A	Poisoning by methadone, intentional self-harm, initial encounter	6	0.09
T403X4A	Poisoning by methadone, undetermined	1	0.02
T404X1A	Poisoning by other synthetic narcotics, accidental (unintentional), initial encounter	119	1.84
T404X2A	Poisoning by other synthetic narcotics, intentional self-harm, initial encounter	51	0.79
T404X4A	Poisoning by other synthetic narcotics, undetermined, initial encounter	20	0.31
TOTAL		6451	100.00

eTable 8 Patient cohort and unadjusted outcomes, stratified by overdose type and treatment status before overdose

Index Emergency Department Opioid Overdose n = 6451				
<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> Heroin Overdose 1896 (29.4%) </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> Prescription Opioid Overdose 4555 (70.6%) </div> </div>				
	No MOUD or Treatment, 90d prior to overdose 1476 (22.9%)	MOUD or Treatment, 90d prior to overdose 420 (6.5%)	No MOUD or Treatment, 90d prior to overdose 4293 (66.5%)	MOUD or Treatment, 90d prior to overdose 262 (4.1%)
Both MOUD and Treatment Encounter, 90d after index opioid overdose	64 (4.3%)	101 (24.0%)	46 (1.1%)	38 (14.5%)
Only MOUD Claim, 90d after index opioid overdose	51 (3.5%)	52 (12.4%)	62 (1.4%)	40 (15.3%)
Only Treatment Encounter, 90d after index opioid overdose	211 (14.3%)	121 (28.8%)	209 (4.9%)	74 (28.2%)
No MOUD or Treatment Encounter, 90d after index opioid overdose	1150 (77.9%)	146 (34.8%)	3976 (92.6%)	110 (42.0%)