

Morphine equivalents conversion table ^a

Opioid	Morphine Equivalents Conversion Factor
Codeine	0.15
Hydrocodone	1
Hydromorphone	4
Meperidine	0.1
Methadone	3
Morphine	1
Opium ^b	1
Oxycodone	1.5
Oxymorphone	3
Fentanyl transdermal (in mcg/hr) ^c	7.2
Tapentadol	1

Notes: ^a Source: Logan et al. (2008) ^b For conversion factor for opium, we used Opioid Dosage Calculator Washington State Agency Medical Directors Group available at <http://agencymeddirectors.wa.gov/mobile.html> ^c Fentanyl Transdermal conversion to morphine equivalents is based on the assumption that one patch remains in place for three days.

ICD-9 codes for health conditions associated with opioid use

Diagnosis	ICD-9-CM codes
Cancer	140-239, 239.XX, 338.3
Arthritis/joint pain	710-720 & 725-740
Back pain	721.3X–721.9X, 722.2X, 722.30, 722.70, 722.80, 722.90, 722.32, 722.72, 722.82, 722.92, 722.33, 722.73, 722.83, 722.93, 724.XX, 737.1, 737.3, 738.4, 738.5, 739.2, 739.3, 739.4, 756.10, 756.11, 756.12, 756.13, 756.19, 805.4, 805.8, 839.2, 839.42, 846, 846.0, 847.1, 847.3, 847.2, & 847.9
Neck pain	721.0X, 721.1X, 722.0X, 722.31, 722.71, 722.81, 722.91, 723.XX, 839.0, 839.1, & 847.0
Headache/migraine	346-347 & 307.81
Fracture	800-829, 905.0-905.5, V13.51, V13.52, V54.0-V54.29, V66.4, & V67.4
Visceral pain	550.0X, 550.1X, 551.0X, 551.1X, 551.2X, 552.0X, 552.1, 552.2X, 560.81, 562.01, 562.03, 562.11, 562.13, 567.2, 567.21, 567.22, 567.31, 567.38, 567.8, 567.82, 567.89, 567.9, 569.5, 574.X, 575.0, 575.1X, 577.0, 577.1, 592.X, 594.X, 596.0, 788.0, 789.0, 789.02, & 789.6X
Wound/injury	860-904.9 & 910-959.9
Neuropathy	053.13, 072.72, 337.0, 337.1, 353-357, 377.33, 377.34, & 377.41
Reproductive system pain	614-617, 625.X, 626.3, & 626.5
Other pain	730.X, 733.0X, & 780.56
Depression	296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 298.0, & 311X
Bipolar	296.0, 296.0X, 296.1, 296.1X, 296.4, 296.4X, 296.5, 296.5X, 296.6, 296.6X, 296.7
Schizophrenia	295.X
Alcohol problem	291.0, 291.3, 291.4, 291.81, 303.0, 305.0, 291.1, 291.2, 291.5, 291.8, 291.82, 291.89, 291.9, 292.0, 292.1, 292.2, 292.81, 303.9, & 305.2-305.7
Drug problem	292.0, 292.1, 292.2, 292.81, 305.2-305.7, 292.82-292.89, 292.9, & 304

Notes: The listed pain diagnosis codes are related to non-cancer pain conditions

Full regression results

	Doctor shopping (N=61,477)	Pharmacy shopping (N=61,477)	Opioid prescription overlap (N=61,477)	Opioid/benzodiazepine overlap (N=61,477)
Age Group				
18-39	-0.0010 (0.0015)	-0.0000 (0.0003)	-0.0031*** (0.0012)	-0.0071*** (0.0015)
40-59	-0.0347*** (0.0024)	-0.0025*** (0.0005)	-0.0036 (0.0021)	0.0056** (0.0026)
60-79	-0.0584*** (0.0039)	-0.0036*** (0.0008)	-0.0133** (0.0053)	-0.0111 (0.0063)
80+	-0.0342*** (0.0113)	-0.0016 (0.0012)	-0.0244*** (0.0073)	-0.0295*** (0.0096)
Male	-0.0009 (0.0015)	0.0004 (0.0004)	-0.0013 (0.0019)	-0.0246*** (0.0022)
Rurality of residence				
Small rural town	0.0057 (0.0092)	0.0001 (0.0007)	-0.0006 (0.0107)	-0.0094 (0.0149)
Large rural town	0.0068 (0.0080)	0.0007 (0.0006)	-0.0041 (0.0088)	-0.0193 (0.0136)
Urban	0.0125 (0.0083)	0.0008 (0.0006)	-0.0027 (0.0090)	-0.0263 (0.0138)
Pain-related diagnosis				
Back pain	0.0156*** (0.0018)	0.0005 (0.0004)	0.0061*** (0.0020)	0.0074*** (0.0023)
Neck pain	0.0223*** (0.0032)	0.0025*** (0.0008)	-0.0015 (0.0031)	0.0097*** (0.0036)
Arthritis/joint pain	0.0018 (0.0014)	0.0002 (0.0003)	0.0021 (0.0016)	-0.0056*** (0.0021)
Headache/migraine	0.0178*** (0.0033)	0.0001 (0.0008)	0.0075** (0.0033)	0.0127*** (0.0041)
Fractures	0.0258*** (0.0037)	0.0023** (0.0010)	-0.0008 (0.0035)	-0.0039 (0.0039)
Visceral pain	0.0400*** (0.0039)	0.0027*** (0.0009)	-0.0029 (0.0030)	-0.0072 (0.0037)
Wound/injury	0.0321*** (0.0022)	0.0017*** (0.0004)	0.0014 (0.0018)	0.0004 (0.0022)
Neuropathy	0.0036 (0.0039)	-0.0007 (0.0009)	0.0128*** (0.0046)	-0.0083 (0.0048)
Reproductive system pain	0.0180*** (0.0027)	0.0017** (0.0006)	-0.0023 (0.0022)	-0.0074*** (0.0027)
Other pain	0.0072 (0.0088)	0.0003 (0.0022)	0.0109 (0.0114)	0.0263** (0.0129)
Other diagnosis				
Depression	0.0161*** (0.0028)	0.0004 (0.0006)	0.0058** (0.0027)	0.0081** (0.0035)

Bipolar	0.0106 (0.0067)	0.0019 (0.0018)	0.0137** (0.0064)	0.0403*** (0.0087)
Schizophrenia	-0.0053 (0.0172)	-0.0071 (0.0065)	-0.0187 (0.0165)	0.0645*** (0.0218)
Alcohol problem	0.0227 (0.0132)	0.0028 (0.0022)	-0.0044 (0.0108)	-0.0126 (0.0142)
Drug problem	-0.0034 (0.0134)	-0.0005 (0.0023)	0.0024 (0.0111)	0.0196 (0.0143)
R-squared	0.13	0.013	0.17	0.19

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05

Regression results used for Figure 2

	Opioid prescription overlap (N=49,765)	Opioid/ benzodiazepine overlap (N=49,765)
Decile 2	-0.0001 (0.0006)	-0.0024** (0.0011)
Decile 3	0.0013** (0.0006)	-0.0032*** (0.0011)
Decile 4	0.0013 (0.0008)	0.0009 (0.0017)
Decile 5	0.0032*** (0.0011)	0.0014 (0.0020)
Decile 6	0.0014 (0.0013)	0.0052** (0.0025)
Decile 7	0.0014 (0.0016)	0.0107*** (0.0033)
Decile 8	0.0193*** (0.0033)	0.0475*** (0.0052)
Decile 9	0.1097*** (0.0079)	0.1274*** (0.0086)
Decile 10	0.2131*** (0.0148)	0.2455*** (0.0159)
Interaction with high-volume provider		
× Decile 2	0.0002 (0.0019)	-0.0029 (0.0074)
× Decile 3	-0.0034 (0.0023)	0.0063 (0.0078)
× Decile 4	-0.0032 (0.0023)	0.0137 (0.0094)
× Decile 5	-0.0051** (0.0022)	0.0181 (0.0095)
× Decile 6	-0.0026 (0.0024)	0.0289** (0.0117)
× Decile 7	0.0058 (0.0045)	0.0250** (0.0099)
× Decile 8	0.0226*** (0.0071)	0.0526*** (0.0111)
× Decile 9	0.0448*** (0.0115)	0.0339*** (0.0125)
× Decile 10	0.0371** (0.0170)	0.0462** (0.0180)
R-squared	0.17	0.20

Robust standard errors in parentheses

*** p<0.01, ** p<0.05

Regression results with alternative definition of high-volume prescribers

	Opioid prescription overlap (N=49,765)	Opioid/ benzodiazepine overlap (N=49,765)
Decile 2	-0.0001 (0.0006)	-0.0024** (0.0011)
Decile 3	0.0011 (0.0006)	-0.0025** (0.0012)
Decile 4	0.0011 (0.0007)	0.0022 (0.0017)
Decile 5	0.0029*** (0.0010)	0.0032 (0.0020)
Decile 6	0.0013 (0.0012)	0.0081*** (0.0026)
Decile 7	0.0022 (0.0016)	0.0125*** (0.0031)
Decile 8	0.0239*** (0.0034)	0.0537*** (0.0049)
Decile 9	0.1237*** (0.0070)	0.1293*** (0.0070)
Decile 10	0.2219*** (0.0115)	0.2441*** (0.0122)
Interaction with high-volume provider		
× Decile 2	-0.0018 (0.0034)	-0.0115 (0.0206)
× Decile 3	-0.0029 (0.0029)	-0.0110 (0.0166)
× Decile 4	-0.0012 (0.0025)	0.0053 (0.0184)
× Decile 5	-0.0031 (0.0037)	0.0114 (0.0197)
× Decile 6	-0.0010 (0.0028)	0.0292 (0.0230)
× Decile 7	0.0077 (0.0062)	0.0317 (0.0183)
× Decile 8	0.0214*** (0.0080)	0.0605*** (0.0186)
× Decile 9	0.0360*** (0.0124)	0.0413** (0.0186)
× Decile 10	0.0329** (0.0148)	0.0530*** (0.0194)
R-squared	0.17	0.20

Robust standard errors in parentheses

*** p<0.01, ** p<0.05

Regression results with alternative assignment rules applied

	Assignment Rule 1 ^a		Assignment Rule 2 ^b		Assignment Rule 3 ^c	
	Opioid prescription overlap (N=50,380)	Opioid/benzodiazepine overlap (N=50,380)	Opioid prescription overlap (N=47,675)	Opioid/benzodiazepine overlap (N=47,675)	Opioid prescription overlap (N=40,309)	Opioid/benzodiazepine overlap (N=40,309)
Decile 2	-0.0001 (0.0006)	-0.0023** (0.0011)	-0.0001 (0.0006)	-0.0023** (0.0011)	-0.0000 (0.0006)	-0.0024** (0.0010)
Decile 3	0.0013** (0.0006)	-0.0032*** (0.0011)	0.0013** (0.0006)	-0.0030*** (0.0011)	0.0012** (0.0006)	-0.0026** (0.0011)
Decile 4	0.0013 (0.0007)	0.0009 (0.0017)	0.0012 (0.0007)	0.0011 (0.0017)	0.0008 (0.0007)	0.0013 (0.0017)
Decile 5	0.0032*** (0.0011)	0.0014 (0.0020)	0.0031*** (0.0011)	0.0018 (0.0020)	0.0030*** (0.0011)	0.0028 (0.0021)
Decile 6	0.0015 (0.0013)	0.0053** (0.0025)	0.0014 (0.0013)	0.0060** (0.0025)	0.0018 (0.0014)	0.0065** (0.0029)
Decile 7	0.0013 (0.0016)	0.0104*** (0.0032)	0.0023 (0.0017)	0.0144*** (0.0035)	0.0038 (0.0021)	0.0203*** (0.0048)
Decile 8	0.0172*** (0.0032)	0.0445*** (0.0050)	0.0242*** (0.0038)	0.0540*** (0.0059)	0.0329*** (0.0057)	0.0708*** (0.0086)
Decile 9	0.1043*** (0.0075)	0.1237*** (0.0083)	0.1130*** (0.0086)	0.1299*** (0.0092)	0.1174*** (0.0112)	0.1337*** (0.0123)
Decile 10	0.2116*** (0.0145)	0.2458*** (0.0156)	0.2048*** (0.0158)	0.2459*** (0.0171)	0.1951*** (0.0194)	0.2585*** (0.0219)
Interaction w/ high-volume provider						
× Decile 2	0.0003 (0.0019)	-0.0031 (0.0074)	-0.0000 (0.0019)	-0.0023 (0.0073)	0.0004 (0.0018)	-0.0018 (0.0071)
× Decile 3	-0.0034	0.0064	-0.0037*	0.0067	-0.0030	0.0076

	(0.0023)	(0.0078)	(0.0022)	(0.0078)	(0.0019)	(0.0075)
× Decile 4	-0.0032	0.0138	-0.0032	0.0142	-0.0018	0.0152
	(0.0023)	(0.0094)	(0.0022)	(0.0094)	(0.0019)	(0.0091)
× Decile 5	-0.0050**	0.0181	-0.0054**	0.0184	-0.0043**	0.0200**
	(0.0022)	(0.0095)	(0.0022)	(0.0095)	(0.0022)	(0.0099)
× Decile 6	-0.0027	0.0291**	-0.0028	0.0292**	-0.0019	0.0384***
	(0.0024)	(0.0117)	(0.0023)	(0.0118)	(0.0024)	(0.0136)
× Decile 7	0.0059	0.0251**	0.0061	0.0260**	0.0068	0.0374***
	(0.0045)	(0.0098)	(0.0047)	(0.0104)	(0.0055)	(0.0125)
× Decile 8	0.0235***	0.0539***	0.0184**	0.0523***	0.0176	0.0588***
	(0.0069)	(0.0108)	(0.0075)	(0.0119)	(0.0101)	(0.0146)
× Decile 9	0.0488***	0.0381***	0.0402***	0.0303**	0.0355**	0.0358**
	(0.0112)	(0.0122)	(0.0122)	(0.0130)	(0.0145)	(0.0157)
× Decile 10	0.0401**	0.0458***	0.0413**	0.0478**	0.0436**	0.0413*
	(0.0168)	(0.0177)	(0.0179)	(0.0192)	(0.0216)	(0.0237)
R-squared	0.17	0.20	0.17	0.20	0.18	0.22

Robust standard errors in parentheses

*** p<0.01, ** p<0.05

^a Assignment rule 1: assign a provider who prescribed opioid the most times

^b Assignment rule2: assign a provider who prescribed opioid the most times and accounted for at least half of each patient's total number of prescription

^c Assignment rule3: assign a provider who prescribed opioid the most times and accounted for at least 75% of each patient's total number of prescription