Impacts of Initial Prescription Length and Prescribing Limits on Risk of Prolonged Postsurgical Opioid Use

Online Supplement

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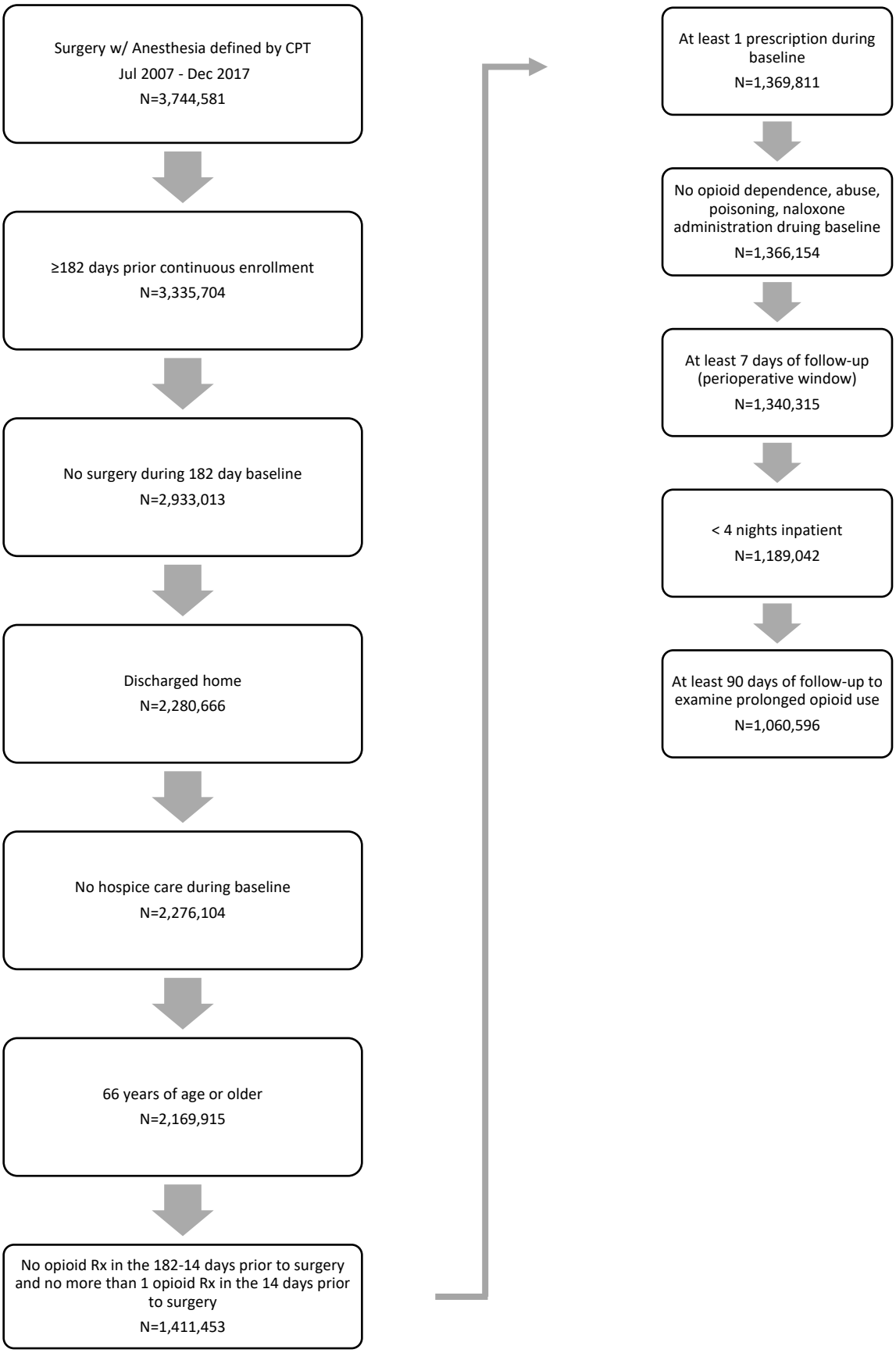
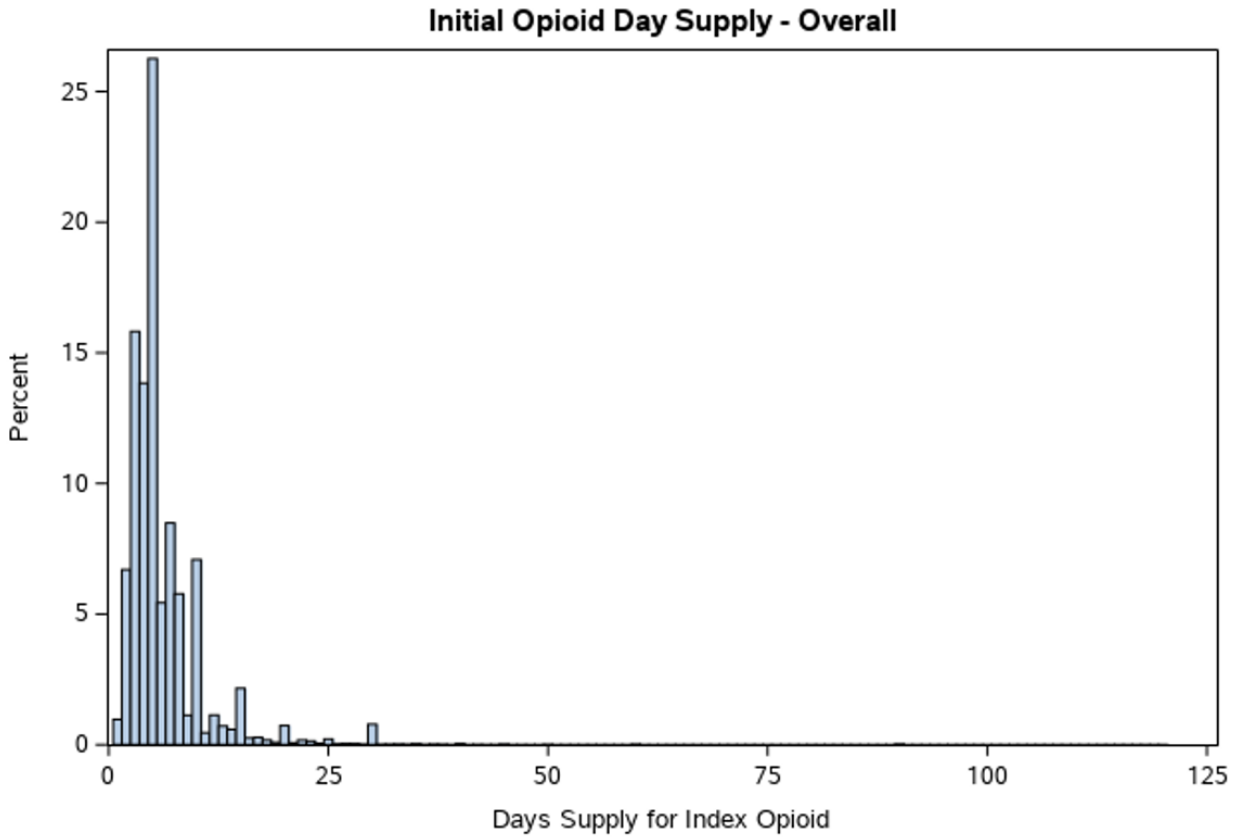
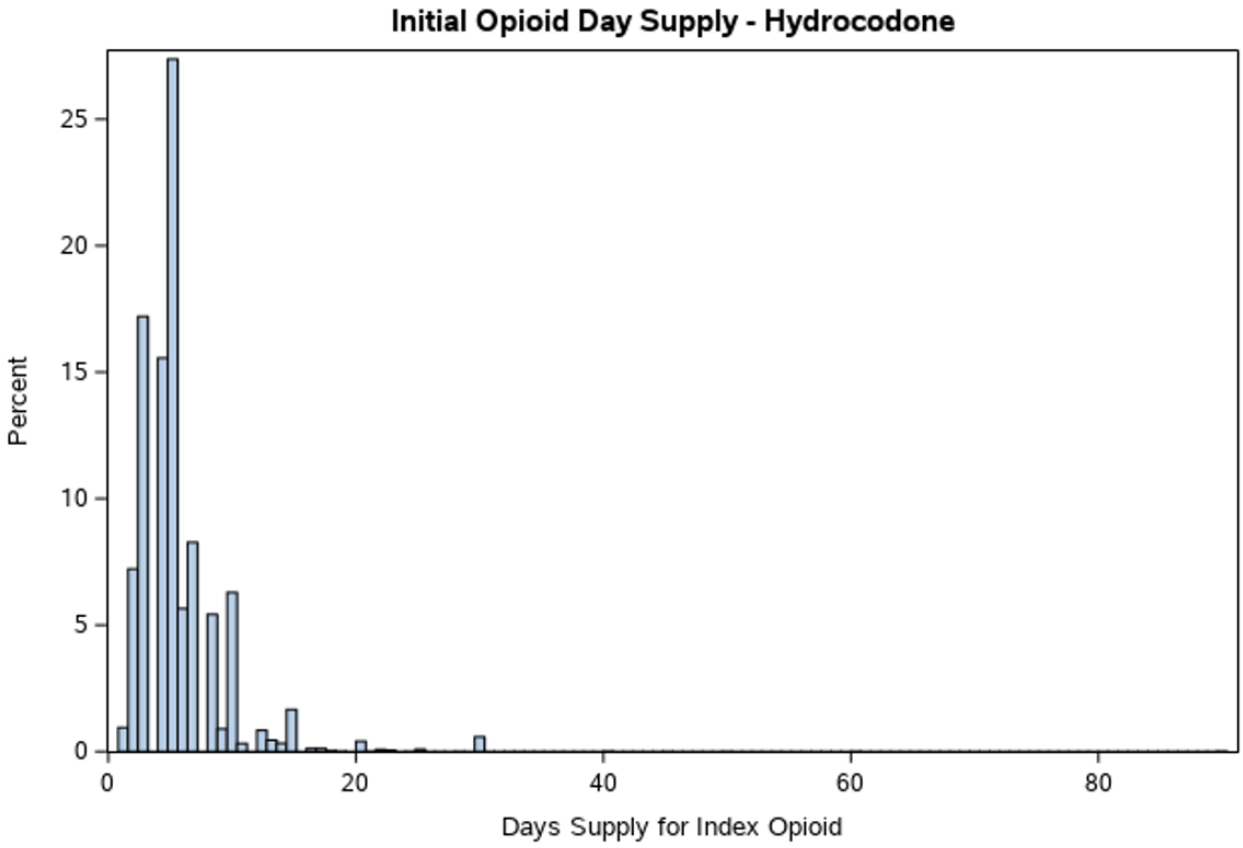


Supplemental Figure 1. Flow Diagram for Study Inclusion

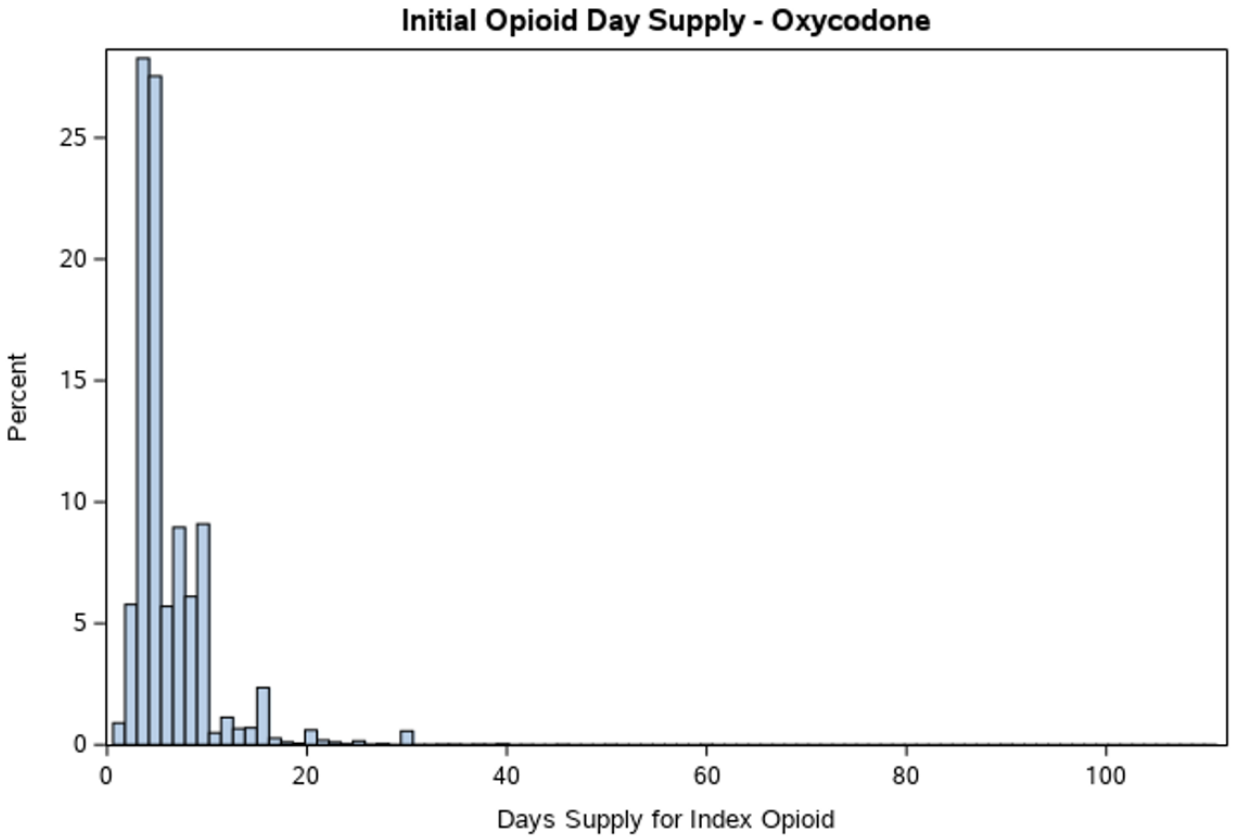
Supplemental Figure 2a. Day supply distribution of the initial opioid prescription – All opioids combined.



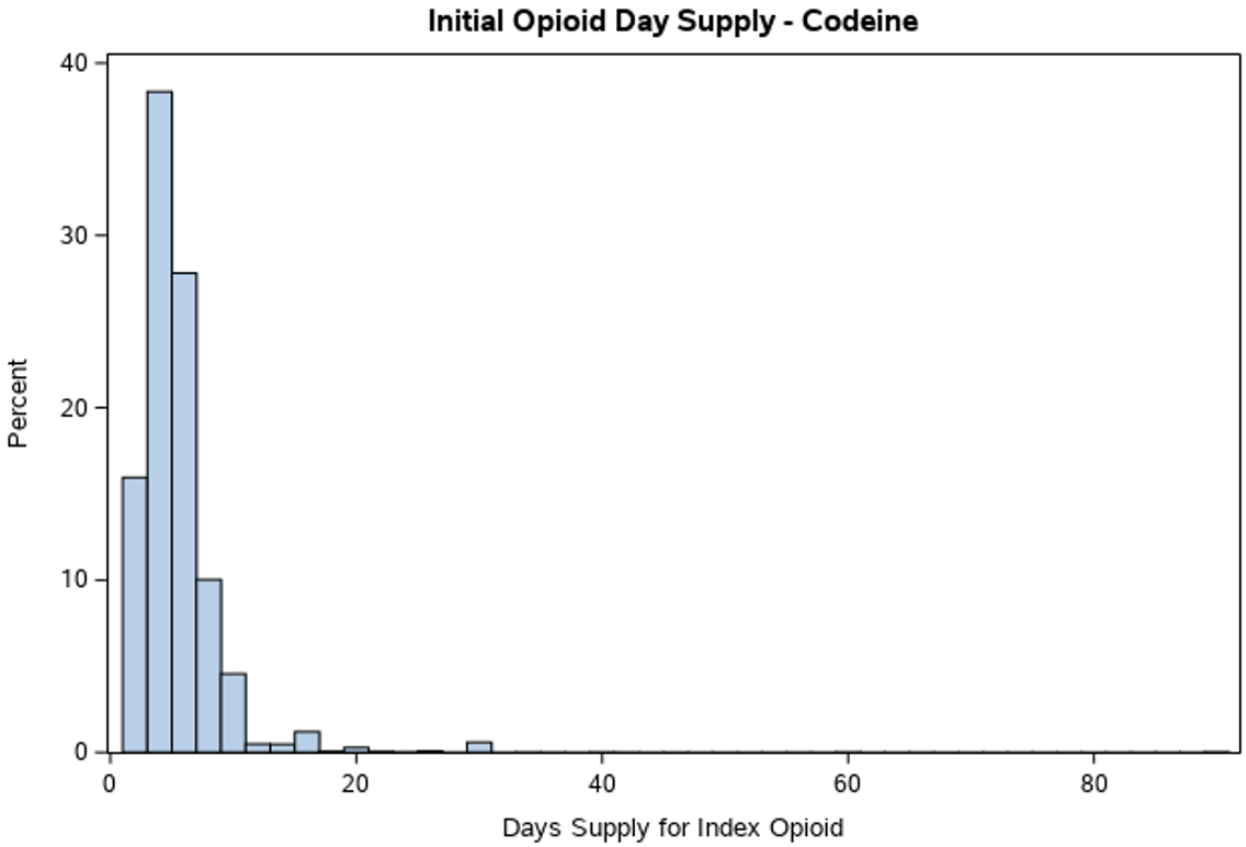
Supplemental Figure 2b. Day supply distribution of the initial opioid prescription: Hydrocodone.



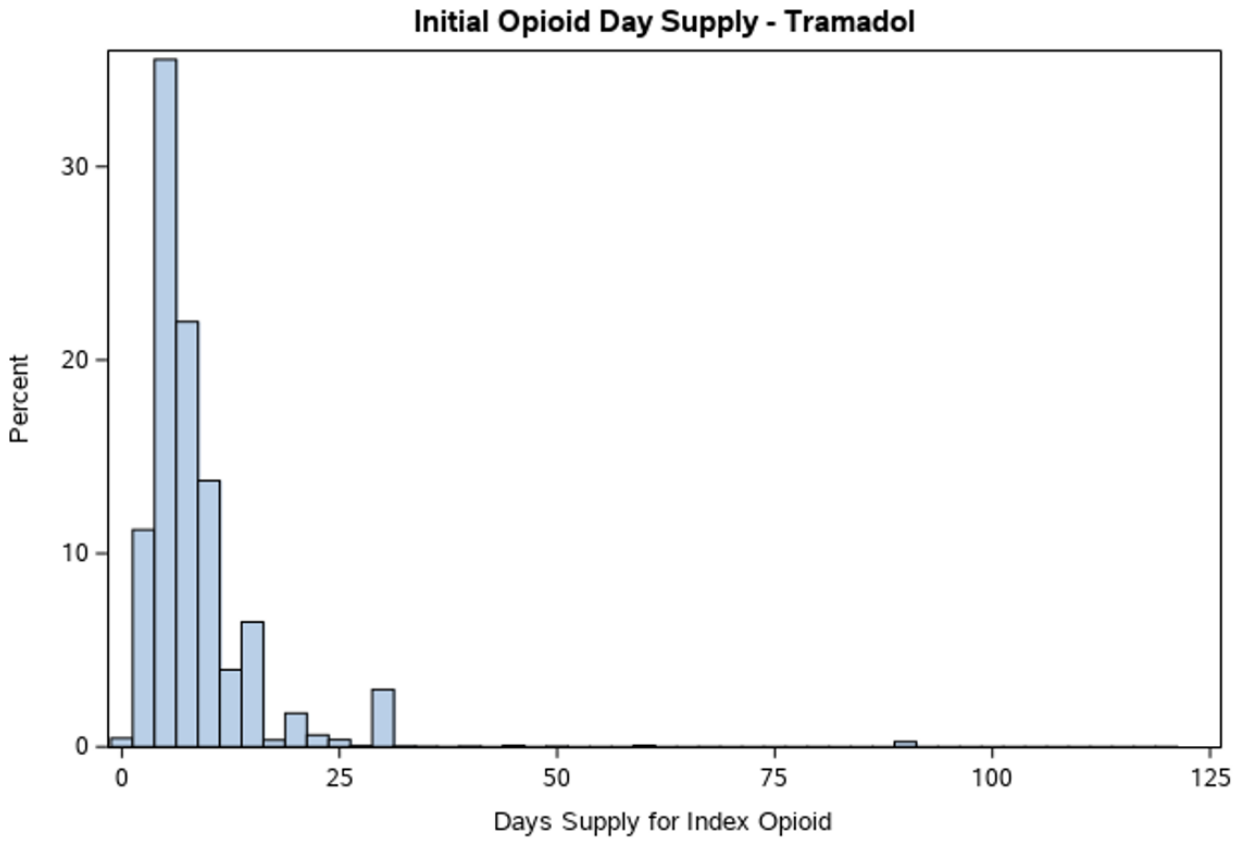
Supplemental Figure 2c. Day supply distribution of the initial opioid prescription: Oxycodone.



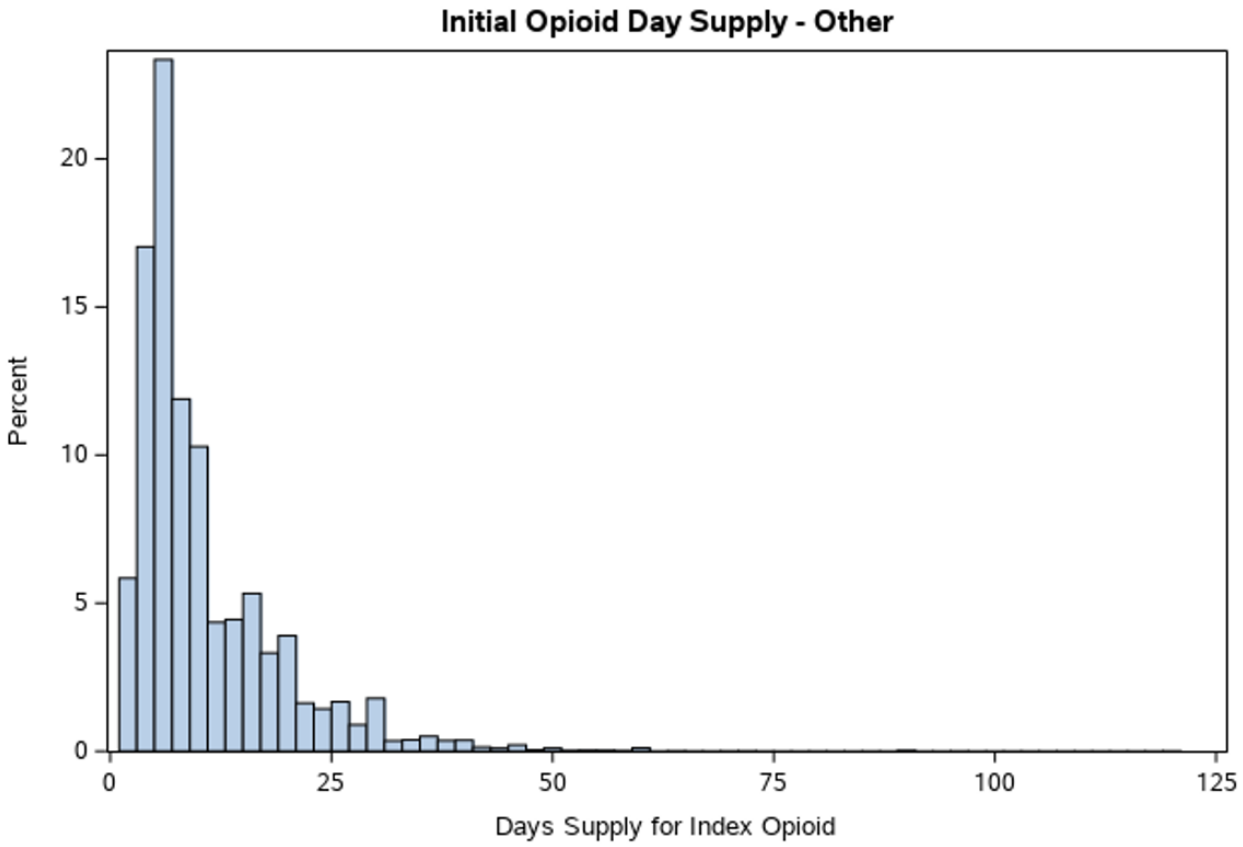
Supplemental Figure 2d. Day supply distribution of the initial opioid prescription: Codeine.

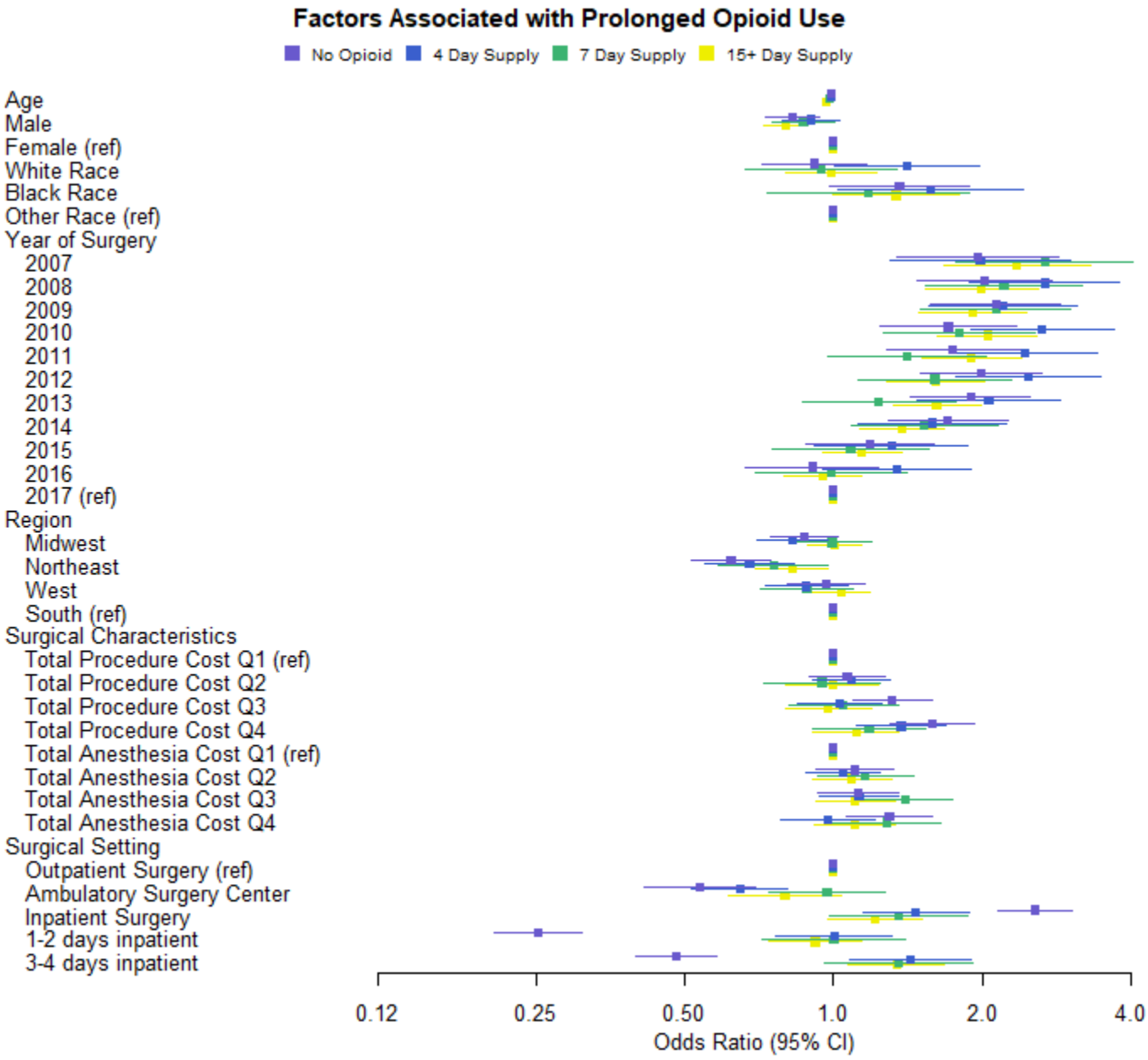


Supplemental Figure 2e. Day supply distribution of the initial opioid prescription: Tramadol.

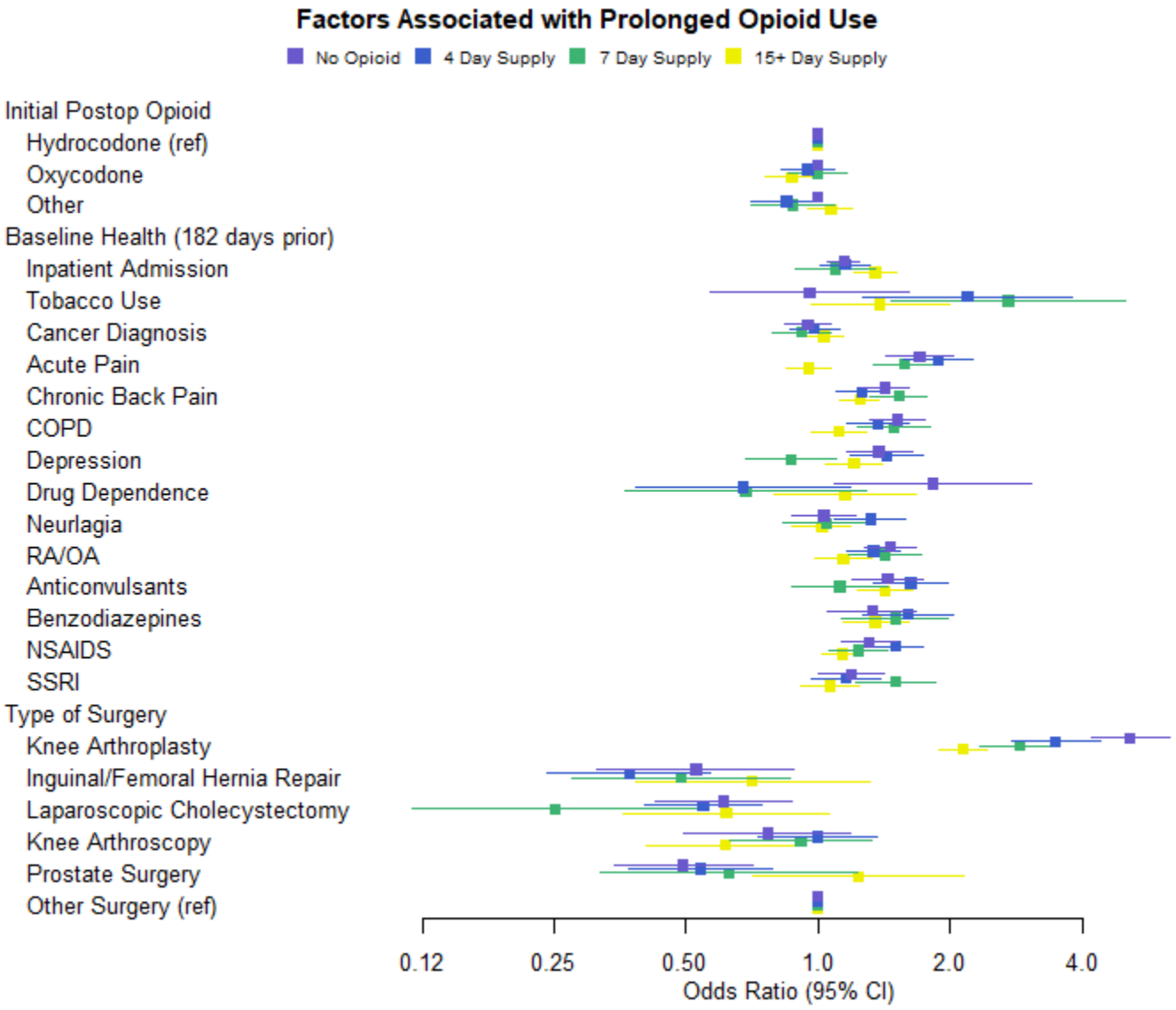


Supplemental Figure 2f. Day supply distribution of the initial opioid prescription: Other.





Supplemental Figure 3a. Predictors of prolonged opioid use for selected day supply categories.



Supplemental Figure 3b. Predictors of prolonged opioid use for selected day supply categories (continued).

Supplemental Table 1. Baseline characteristics for Medicare patients undergoing surgery, stratified by initial days supplied.

Characteristic	No Opioid Rx	1 Day Supply	2 Day Supply	3 Day Supply	4 Day Supply	5 Day Supply	6 Day Supply	7 Day Supply	8 Day Supply	9-10 Day Supply	11-14 Day Supply	15+ Day Supply
	N=315,487	N=7,231	N=49,931	N=117,862	N=103,119	N=195,672	N=40,493	N=63,247	N=43,035	N=61,211	N=21,549	N=41,753
Age, mean(SD)	75.9(6.98)	74.8(6.51)	74.3(6.40)	73.8(6.18)	73.5(6.02)	73.5(5.98)	73.3(5.84)	73.4(5.89)	73.2(5.68)	73.1(5.66)	72.9(5.45)	73.1(5.63)
Sex, Male	147,936 (46.9%)	2,995 (41.4%)	22,098 (44.3%)	53,022 (45.0%)	46,327 (44.9%)	85,550 (43.7%)	17,500 (43.2%)	27,268 (43.1%)	18,377 (42.7%)	26,010 (42.5%)	9,196 (42.7%)	17,479 (41.9%)
Race												
White	284,286 (90.1%)	6,636 (91.8%)	45,657 (91.4%)	107,298 (91.0%)	94,075 (91.2%)	176,975 (90.4%)	36,770 (90.8%)	56,999 (90.1%)	39,000 (90.6%)	55,274 (90.3%)	19,715 (91.5%)	37,596 (90.0%)
Black	13,603 (4.3%)	267 (3.7%)	2,075 (4.2%)	4,923 (4.2%)	4,074 (4.0%)	8,758 (4.5%)	1,802 (4.5%)	2,937 (4.6%)	1,774 (4.1%)	2,595 (4.2%)	752 (3.5%)	1,761 (4.2%)
Asian	4,948 (1.6%)	72 (1.0%)	571 (1.1%)	1,392 (1.2%)	1,154 (1.1%)	2,501 (1.3%)	475 (1.2%)	884 (1.4%)	558 (1.3%)	837 (1.4%)	267 (1.2%)	588 (1.4%)
Hispanic	5,409 (1.7%)	89 (1.2%)	568 (1.1%)	1,539 (1.3%)	1,292 (1.3%)	2,814 (1.4%)	576 (1.4%)	932 (1.5%)	628 (1.5%)	948 (1.5%)	244 (1.1%)	674 (1.6%)
Other	4,412 (1.4%)	102 (1.4%)	592 (1.2%)	1,473 (1.2%)	1,344 (1.3%)	2,452 (1.3%)	455 (1.1%)	816 (1.3%)	568 (1.3%)	783 (1.3%)	292 (1.4%)	584 (1.4%)
Year of Surgery												
2007	12,145 (3.8%)	425 (5.9%)	2,270 (4.5%)	4,578 (3.9%)	3,721 (3.6%)	6,544 (3.3%)	1,535 (3.8%)	1,718 (2.7%)	971 (2.3%)	1,442 (2.4%)	378 (1.8%)	721 (1.7%)
2008	24,744 (7.8%)	783 (10.8%)	4,257 (8.5%)	8,969 (7.6%)	7,559 (7.3%)	14,182 (7.2%)	3,359 (8.3%)	3,811 (6.0%)	2,415 (5.6%)	3,267 (5.3%)	949 (4.4%)	1,772 (4.2%)
2009	25,262 (8.0%)	781 (10.8%)	4,735 (9.5%)	9,914 (8.4%)	7,897 (7.7%)	14,538 (7.4%)	3,577 (8.8%)	4,035 (6.4%)	2,551 (5.9%)	3,488 (5.7%)	999 (4.6%)	1,885 (4.5%)
2010	25,445 (8.1%)	775 (10.7%)	4,728 (9.5%)	10,209 (8.7%)	8,064 (7.8%)	15,000 (7.7%)	3,601 (8.9%)	4,352 (6.9%)	2,760 (6.4%)	3,687 (6.0%)	1,229 (5.7%)	2,267 (5.4%)
2011	25,709 (8.1%)	551 (7.6%)	4,059 (8.1%)	9,998 (8.5%)	9,449 (9.2%)	16,047 (8.2%)	3,655 (9.0%)	4,758 (7.5%)	3,249 (7.5%)	4,081 (6.7%)	1,257 (5.8%)	2,393 (5.7%)
2012	28,689 (9.1%)	573 (7.9%)	4,365 (8.7%)	10,302 (8.7%)	9,496 (9.2%)	16,947 (8.7%)	3,700 (9.1%)	5,045 (8.0%)	3,756 (8.7%)	4,589 (7.5%)	1,586 (7.4%)	2,788 (6.7%)
2013	31,713 (10.1%)	559 (7.7%)	4,873 (9.8%)	11,915 (10.1%)	10,844 (10.5%)	20,249 (10.3%)	4,121 (10.2%)	6,202 (9.8%)	4,480 (10.4%)	5,862 (9.6%)	1,968 (9.1%)	3,747 (9.0%)
2014	34,381 (10.9%)	572 (7.9%)	4,829 (9.7%)	13,303 (11.3%)	11,601 (11.3%)	22,452 (11.5%)	4,247 (10.5%)	7,300 (11.5%)	5,056 (11.7%)	7,160 (11.7%)	2,476 (11.5%)	4,792 (11.5%)
2015	36,121 (11.4%)	586 (8.1%)	4,766 (9.5%)	13,179 (11.2%)	12,012 (11.6%)	24,068 (12.3%)	4,406 (10.9%)	8,430 (13.3%)	5,960 (13.8%)	8,926 (14.6%)	3,451 (16.0%)	6,814 (16.3%)
2016	40,160 (12.7%)	776 (10.7%)	5,879 (11.8%)	14,460 (12.3%)	12,800 (12.4%)	25,806 (13.2%)	4,778 (11.8%)	9,611 (15.2%)	6,665 (15.5%)	10,151 (16.6%)	4,073 (18.9%)	8,077 (19.3%)
2017	31,118 (9.9%)	850 (11.8%)	5,170 (10.4%)	11,035 (9.4%)	9,676 (9.4%)	19,839 (10.1%)	3,514 (8.7%)	7,985 (12.6%)	5,172 (12.0%)	8,558 (14.0%)	3,183 (14.8%)	6,497 (15.6%)
Region												
Northeast	64,947 (20.6%)	1,473 (20.4%)	9,092 (18.2%)	18,827 (16.0%)	15,099 (14.6%)	28,859 (14.7%)	5,109 (12.6%)	9,153 (14.5%)	5,873 (13.6%)	8,366 (13.7%)	3,119 (14.5%)	5,414 (13.0%)
Midwest	65,762 (20.8%)	1,411 (19.5%)	10,715 (21.5%)	26,760 (22.7%)	24,821 (24.1%)	43,020 (22.0%)	8,751 (21.6%)	14,468 (22.9%)	9,969 (23.2%)	13,610 (22.2%)	5,353 (24.8%)	9,715 (23.3%)
South	101,946 (32.3%)	2,128 (29.4%)	15,824 (31.7%)	39,722 (33.7%)	34,029 (33.0%)	71,509 (36.5%)	14,693 (36.3%)	23,334 (36.9%)	16,349 (38.0%)	23,357 (38.2%)	7,392 (34.3%)	15,914 (38.1%)
West	47,280 (15.0%)	1,065 (14.7%)	8,001 (16.0%)	19,515 (16.6%)	18,288 (17.7%)	32,353 (16.5%)	7,275 (18.0%)	10,958 (17.3%)	7,546 (17.5%)	11,335 (18.5%)	4,416 (20.5%)	8,306 (19.9%)
Other	671 (0.2%)	NTSR	55 (0.1%)	177 (0.2%)	111 (0.1%)	268 (0.1%)	42 (0.1%)	80 (0.1%)	71 (0.2%)	73 (0.1%)	23 (0.1%)	55 (0.1%)
Total Cost (USD) of Procedure, mean(SD)	4603.4(6365.25)	4587.3(5719.78)	4606.7(5634.94)	5049.1(6579.75)	5515.7(7221.16)	6036.0(7747.79)	6374.7(7891.35)	6411.6(7835.88)	6797.6(8077.75)	7547.6(8868.99)	7927.4(8576.60)	8124.8(9552.59)
Total Cost (USD) of Anesthesia, mean(SD)	1698.5(1321.41)	1434.6(1018.28)	1453.9(1055.96)	1524.7(1122.33)	1554.2(1191.07)	1683.2(1274.03)	1682.8(1253.86)	1826.4(1402.60)	1927.2(1406.78)	2012.0(1458.10)	2157.2(1485.39)	2246.5(1527.61)

Characteristic	No Opioid Rx	1 Day Supply	2 Day Supply	3 Day Supply	4 Day Supply	5 Day Supply	6 Day Supply	7 Day Supply	8 Day Supply	9-10 Day Supply	11-14 Day Supply	15+ Day Supply
	N=315,487	N=7,231	N=49,931	N=117,862	N=103,119	N=195,672	N=40,493	N=63,247	N=43,035	N=61,211	N=21,549	N=41,753
Place of Service												
Ambulatory Surgical Center	47,556 (15.1%)	1,650 (22.8%)	11,679 (23.4%)	26,084 (22.1%)	22,382 (21.7%)	38,580 (19.7%)	7,873 (19.4%)	10,509 (16.6%)	6,178 (14.4%)	8,601 (14.1%)	2,175 (10.1%)	3,809 (9.1%)
Outpatient Hospital	158,786 (50.3%)	4,097 (56.7%)	28,774 (57.6%)	66,958 (56.8%)	56,478 (54.8%)	99,078 (50.6%)	19,226 (47.5%)	29,405 (46.5%)	17,723 (41.2%)	22,897 (37.4%)	6,321 (29.3%)	11,238 (26.9%)
Inpatient Hospital	104,324 (33.1%)	1,327 (18.4%)	8,734 (17.5%)	23,466 (19.9%)	23,144 (22.4%)	55,974 (28.6%)	13,037 (32.2%)	22,732 (35.9%)	18,781 (43.6%)	29,223 (47.7%)	12,911 (59.9%)	26,422 (63.3%)
Other	4,821 (1.5%)	157 (2.2%)	744 (1.5%)	1,354 (1.1%)	1,115 (1.1%)	2,040 (1.0%)	357 (0.9%)	601 (1.0%)	353 (0.8%)	490 (0.8%)	142 (0.7%)	284 (0.7%)
Days Inpatient, mean(SD)	2.2(1.07)	2.1(1.03)	2.1(1.06)	2.2(1.07)	2.2(1.04)	2.3(1.02)	2.3(1.00)	2.3(1.00)	2.3(0.98)	2.3(0.97)	2.3(0.94)	2.2(0.95)
Baseline Diagnoses												
Cancer	124,912 (39.6%)	2,996 (41.4%)	19,844 (39.7%)	44,431 (37.7%)	36,917 (35.8%)	68,552 (35.0%)	13,346 (33.0%)	21,495 (34.0%)	13,790 (32.0%)	18,759 (30.6%)	6,458 (30.0%)	12,429 (29.8%)
Acute Pain	14,386 (4.6%)	299 (4.1%)	2,095 (4.2%)	6,970 (5.9%)	9,267 (9.0%)	23,502 (12.0%)	5,730 (14.2%)	9,462 (15.0%)	8,136 (18.9%)	13,145 (21.5%)	5,837 (27.1%)	11,025 (26.4%)
Chronic Back Pain	84,434 (26.8%)	1,770 (24.5%)	12,022 (24.1%)	29,601 (25.1%)	26,638 (25.8%)	54,230 (27.7%)	11,669 (28.8%)	19,317 (30.5%)	14,168 (32.9%)	21,713 (35.5%)	8,151 (37.8%)	16,980 (40.7%)
COPD	51,271 (16.3%)	994 (13.7%)	6,587 (13.2%)	15,428 (13.1%)	13,214 (12.8%)	25,711 (13.1%)	5,080 (12.5%)	8,231 (13.0%)	5,164 (12.0%)	7,234 (11.8%)	2,429 (11.3%)	5,069 (12.1%)
Depression	33,811 (10.7%)	751 (10.4%)	5,086 (10.2%)	11,907 (10.1%)	10,560 (10.2%)	21,270 (10.9%)	4,267 (10.5%)	7,315 (11.6%)	5,040 (11.7%)	7,187 (11.7%)	2,669 (12.4%)	5,455 (13.1%)
Drug Dependence	16,306 (5.2%)	311 (4.3%)	2,621 (5.2%)	6,444 (5.5%)	5,517 (5.4%)	10,441 (5.3%)	2,267 (5.6%)	3,267 (5.2%)	2,131 (5.0%)	2,999 (4.9%)	982 (4.6%)	2,026 (4.9%)
Neuralgia	35,671 (11.3%)	627 (8.7%)	4,231 (8.5%)	10,329 (8.8%)	8,876 (8.6%)	18,077 (9.2%)	3,845 (9.5%)	6,231 (9.9%)	4,175 (9.7%)	6,357 (10.4%)	2,105 (9.8%)	4,492 (10.8%)
Rheumatoid / Osteoarthritis	116,607 (37.0%)	2,517 (34.8%)	16,569 (33.2%)	42,187 (35.8%)	41,973 (40.7%)	91,409 (46.7%)	20,804 (51.4%)	33,705 (53.3%)	26,311 (61.1%)	40,204 (65.7%)	16,278 (75.5%)	32,353 (77.5%)
Baseline Medications												
Anticonvulsants	21,149 (6.7%)	465 (6.4%)	3,001 (6.0%)	7,351 (6.2%)	6,660 (6.5%)	13,906 (7.1%)	2,883 (7.1%)	4,987 (7.9%)	3,544 (8.2%)	5,533 (9.0%)	2,002 (9.3%)	4,595 (11.0%)
Antidementia	11,823 (3.7%)	222 (3.1%)	1,269 (2.5%)	2,767 (2.3%)	2,265 (2.2%)	4,454 (2.3%)	865 (2.1%)	1,384 (2.2%)	849 (2.0%)	1,225 (2.0%)	305 (1.4%)	804 (1.9%)
Anxiolytics	20,719 (6.6%)	470 (6.5%)	3,476 (7.0%)	8,469 (7.2%)	7,283 (7.1%)	14,788 (7.6%)	2,956 (7.3%)	5,189 (8.2%)	3,355 (7.8%)	5,092 (8.3%)	1,875 (8.7%)	3,747 (9.0%)
Benzodiazepines	16,825 (5.3%)	380 (5.3%)	2,768 (5.5%)	6,678 (5.7%)	5,735 (5.6%)	11,803 (6.0%)	2,298 (5.7%)	4,217 (6.7%)	2,721 (6.3%)	4,191 (6.8%)	1,572 (7.3%)	3,121 (7.5%)
NSAIDS	43,820 (13.9%)	1,149 (15.9%)	7,719 (15.5%)	19,743 (16.8%)	18,990 (18.4%)	39,015 (19.9%)	8,892 (22.0%)	13,409 (21.2%)	9,934 (23.1%)	15,078 (24.6%)	5,630 (26.1%)	11,203 (26.8%)
SSRI	37,443 (11.9%)	893 (12.3%)	6,256 (12.5%)	14,425 (12.2%)	12,747 (12.4%)	24,558 (12.6%)	5,094 (12.6%)	7,930 (12.5%)	5,326 (12.4%)	7,573 (12.4%)	2,696 (12.5%)	5,339 (12.8%)
# of Inpatient Stays During Baseline												
0	277,642 (88.0%)	6,639 (91.8%)	46,211 (92.5%)	109,371 (92.8%)	96,463 (93.5%)	182,977 (93.5%)	38,147 (94.2%)	59,305 (93.8%)	40,684 (94.5%)	58,160 (95.0%)	20,645 (95.8%)	39,673 (95.0%)
1	27,995 (8.9%)	460 (6.4%)	2,941 (5.9%)	6,683 (5.7%)	5,290 (5.1%)	10,074 (5.1%)	1,900 (4.7%)	3,198 (5.1%)	1,894 (4.4%)	2,483 (4.1%)	742 (3.4%)	1,680 (4.0%)
2	6,892 (2.2%)	98 (1.4%)	556 (1.1%)	1,366 (1.2%)	1,022 (1.0%)	1,959 (1.0%)	321 (0.8%)	541 (0.9%)	332 (0.8%)	413 (0.7%)	111 (0.5%)	292 (0.7%)
3+	2,958 (0.9%)	34 (0.5%)	223 (0.4%)	442 (0.4%)	344 (0.3%)	662 (0.3%)	125 (0.3%)	203 (0.3%)	125 (0.3%)	155 (0.3%)	51 (0.2%)	108 (0.3%)
Initial Opioid Type												
Codeine	-	859 (11.9%)	5,199 (10.4%)	9,190 (7.8%)	5,369 (5.2%)	9,157 (4.7%)	1,404 (3.5%)	2,481 (3.9%)	1,327 (3.1%)	1,731 (2.8%)	362 (1.7%)	894 (2.1%)

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	N=315,487	N=7,231	N=49,931	N=117,862	N=103,119	N=195,672	N=40,493	N=63,247	N=43,035	N=61,211	N=21,549	N=41,753
Dextropropoxyphene	-	382 (5.3%)	1,942 (3.9%)	3,391 (2.9%)	3,035 (2.9%)	7,128 (3.6%)	1,452 (3.6%)	2,096 (3.3%)	854 (2.0%)	1,690 (2.8%)	250 (1.2%)	715 (1.7%)
Hydrocodone	-	3,603 (49.8%)	27,457 (55.0%)	65,424 (55.5%)	59,173 (57.4%)	104,105 (53.2%)	21,495 (53.1%)	31,451 (49.7%)	20,620 (47.9%)	27,315 (44.6%)	7,346 (34.1%)	12,343 (29.6%)
Hydromorphone	-	106 (1.5%)	577 (1.2%)	1,166 (1.0%)	1,020 (1.0%)	2,146 (1.1%)	626 (1.5%)	925 (1.5%)	720 (1.7%)	1,211 (2.0%)	391 (1.8%)	495 (1.2%)
Oxycodone	-	2,059 (28.5%)	13,255 (26.5%)	34,903 (29.6%)	29,977 (29.1%)	63,189 (32.3%)	13,075 (32.3%)	20,546 (32.5%)	14,008 (32.6%)	20,866 (34.1%)	6,837 (31.7%)	10,745 (25.7%)
Tramadol	-	189 (2.6%)	1,328 (2.7%)	3,426 (2.9%)	4,154 (4.0%)	9,149 (4.7%)	1,751 (4.3%)	4,990 (7.9%)	4,320 (10.0%)	5,643 (9.2%)	2,165 (10.0%)	5,239 (12.5%)
Multiple	-	-	31 (0.1%)	31 (0.0%)	171 (0.2%)	249 (0.1%)	558 (1.4%)	573 (0.9%)	1,062 (2.5%)	2,460 (4.0%)	4,097 (19.0%)	10,972 (26.3%)
Other	-	33 (0.5%)	142 (0.3%)	331 (0.3%)	220 (0.2%)	549 (0.3%)	132 (0.3%)	185 (0.3%)	124 (0.3%)	295 (0.5%)	101 (0.5%)	350 (0.8%)

Abbreviations: SD, Standard Deviation; USD, United States Dollars

Supplemental Table 2. Most common surgeries (>1%)

Surgery	**Number of Procedures**	**% of Total**
Knee Arthroplasty	78,096	7.4%
Inguinal / Femoral Hernia Repair	61,110	5.8%
Laparoscopic Cholecystectomy	55,240	5.2%
Prostate Surgery	52,411	4.9%
Knee Arthroscopy	52,231	4.9%
Cardiac Pacemaker	45,346	4.3%
Skin Graft	40,121	3.8%
Lumpectomy	36,936	3.5%
Other Hernia Repair	34,764	3.3%
Hip Replacement	31,451	3.0%
Carpal Tunnel Surgery	29,690	2.8%
Bunionectomy	26,600	2.5%
Rotator Cuff Repair	26,014	2.5%
Laminectomy	23,728	2.2%
Endarterectomy	22,157	2.1%
Hysterectomy	19,030	1.8%
Finger Tendon	17,514	1.7%
AV Fistula	17,111	1.6%
Genitourinary Incontinence	15,823	1.5%
Shoulder Arthroplasty	14,208	1.3%
Colorectal Resection	14,146	1.3%
Spinal Fusion	14,132	1.3%
Decompression Peripheral Nerve	13,385	1.3%
Mastectomy	12,158	1.1%
Other Surgery	294,504	29.0%

Supplemental Table 3. Observed and expected risk of prolonged opioid use by initial number of days supplied.

Initial Days Supplied	# of Surgeries	Observed Risk / 1,000 (95% CI)	Expected Risk[a] / 1,000 (95% CI)
No Opioid Rx	315,487	3.7 (3.5, 3.9)	5.2 (4.9, 5.6)
1	7,231	6.8 (4.9, 8.7)	12.6 (7.1, 18.1)
2	49,931	7.3 (6.5, 8.0)	12.5 (10.7, 14.4)
3	117,862	9.2 (8.7, 9.8)	13.5 (12.4, 14.6)
4	103,119	12.3 (11.7, 13.0)	14.1 (13.1, 15.2)
5	195,672	16.7 (16.1, 17.3)	15.8 (15.2, 16.5)
6	40,493	21.4 (20.0, 22.8)	17.1 (15.6, 18.7)
7	63,247	23.3 (22.1, 24.4)	18.4 (17.3, 19.5)
8	43,035	28.3 (26.7, 29.9)	18.9 (17.6, 20.2)
9-10	61,211	31.7 (30.4, 33.1)	21.2 (20.0, 22.5)
11-14	21,549	38.1 (35.5, 40.6)	22.2 (20.1, 24.4)
15+	41,753	43.6 (41.6, 45.5)	30.2 (28.0, 32.3)

[a]Expected risk in the overall population was estimated using g-computation with 200 bootstraps. Confidence intervals were estimated using the normal approximation.

Supplemental Table 4. Observed and adjusted risk of prolonged opioid use by initial dosage dispensed.

Initial MME Dispensed	# of Surgeries	Observed Risk / 1,000 (95% CI)	Adjusted Risk / 1,000 (95% CI)
No Rx Opioid	315,487	3.7 (3.5, 3.9)	5.2 (4.9, 5.6)
0<=MME<90	26,049	8.7 (7.6, 9.8)	13.7 (11.2 1 6.3)
90<=MME<120	32,159	6.4 (5.6, 7.3)	11.5 (8.9, 14.1)
120<=MME<135	44,735	7.2 (6.5, 8.0)	14.0 (7.9, 20.1)
135<=MME<150	21,126	8.7 (7.4, 9.9)	17.8 (12.0, 23.6)
150<=MME<180	35,055	6.0 (5.2, 6.9)	12.6 (9.3, 15.8)
180<=MME<225	131,149	9.9 (9.4, 10.4)	13.6 (12.3, 14.9)
225<=MME<240	60,228	10.0 (9.2, 10.8)	16.2 (12.8, 19.6)
240<=MME<270	50,697	14.8 (13.8, 15.9)	17.6 (14.6, 20.5)
270<=MME<300	31,813	14.8 (13.5, 16.1)	17.0 (14.3, 19.7)
300<=MME<360	77,951	17.5 (16.6, 18.4)	17.2 (16.1, 18.2)
360<=MME<375	42,392	25.5 (24.0, 27.0)	18.1 (13.5, 22.7)
375<=MME<450	29,921	25.6 (23.8, 27.4)	19.7 (17.6, 21.7)
450<=MME<486	50,060	34.1 (32.5, 35.7)	22.6 (20.3, 25.0)
486<=MME<600	23,344	39.7 (37.2, 42.2)	25.0 (22.5, 27.5)
600<=MME<800	50,933	43.0 (41.3, 44.8)	26.0 (24.0, 28.0)
MME>=800	37,491	49.9 (47.6, 52.1)	30.5 (27.1, 33.9)

Supplemental Table 5. Risk difference for prolonged opioid use per 1000 patients and projected number of reduced cases of prolonged opioid use associated with varying dosage limits.

Dosage Dispensed Limit	Observed Risk/1,000 Above Limit	Estimated Risk/1,000 At Limit[a]	Risk Difference (95% CI)	NNT[b]	No. (%) of Surgeries above Cutoff	# of Reduced Prolonged Opioid Use Cases[c]
120 MME	20.89	19.12	1.77 (-7.33,10.87)	565	643,163 (86.3%)	1,138
150 MME	22.16	15.49	6.66 (1.70,11.62)	151	588,921 (79.0%)	3,900
180 MME	24.99	19.78	5.21 (1.72,8.70)	192	477,789 (64.1%)	2,488
225 MME	28.20	24.60	3.60 (-1.90,9.09)	278	395,068 (53.0%)	1,421
240 MME	29.90	21.32	8.59 (-1.00,18.17)	117	349,394 (46.9%)	2,986
270 MME	31.65	25.58	6.07 (-0.05,12.19)	165	313,981 (42.1%)	1,902
300 MME	35.72	30.67	5.04 (2.76,7.32)	199	243,986 (32.7%)	1,226
360 MME	38.88	33.15	5.73 (-5.32,16.79)	175	192,057 (25.8%)	1,097
450 MME	43.81	42.59	1.22 (-3.36,5.80)	820	123,014 (16.5%)	150

[a]Risk calculated using g-computation methods with 95% confidence intervals based on the standard deviation of 200 bootstrapped resamples, estimating risk of prolonged use if all patients above the limit had instead received a prescription equal to that limit.

[b]NNT: Number needed to treat = RD^{-1}, interpreted as the number of patients needed to be impacted by the limit to reduce one case of prolonged opioid use.

[c]# of Reduced Cases = (# of surgeries above cutoff / NNT)

Supplemental Table 6. Median and interquartile ranges for total morphine milligram equivalents and quantity dispensed by day supply category: overall and stratified by calendar period.

Day Supply Category	Overall		2007-2010		2011-2014		2015-2017	
	Total MME Dispensed	Quantity Dispensed	Total MME Dispensed	Quantity Dispensed	Total MME Dispensed	Quantity Dispensed	Total MME Dispensed	Quantity Dispensed
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
1 Day Supply	60 (45,100)	10 (6,15)	90 (60,120)	14 (10,20)	60 (36,90)	10 (6,12)	60 (37.5,72)	10 (5,10)
2 Day Supply	120 (90,150)	20 (12,20)	150 (90,180)	20 (15,30)	120 (90,150)	20 (12,20)	100 (75,120)	15 (10,20)
3 Day Supply	180 (120,225)	30 (20,30)	180 (120,240)	25 (20,30)	180 (120,225)	28 (20,30)	180 (120,225)	30 (20,30)
4 Day Supply	200 (180,288)	30 (24,40)	187.5 (180,270)	30 (24,30)	200 (180,300)	30 (25,40)	225 (150,300)	30 (24,40)
5 Day Supply	240 (180,360)	30 (30,40)	240 (180,300)	30 (30,40)	240 (180,360)	30 (30,40)	240 (180,360)	30 (30,45)
6 Day Supply	300 (240,400)	40 (30,50)	300 (240,375)	40 (30,40)	300 (240,400)	40 (30,50)	300 (240,400)	40 (32,50)
7 Day Supply	300 (225,450)	40 (30,50)	300 (225,400)	40 (30,50)	300 (225,450)	40 (30,50)	300 (225,450)	40 (30,50)
8 Day Supply	360 (270,540)	50 (30,60)	360 (270,450)	50 (35,60)	360 (270,540)	50 (30,60)	375 (270,600)	50 (30,60)
9-10 Day Supply	450 (300,600)	60 (40,60)	400 (300,540)	50 (40,60)	450 (300,600)	60 (40,60)	450 (360,675)	60 (40,60)
11-14 Day Supply	600 (450,825)	80 (50,90)	552 (405,750)	70 (50,90)	600 (450,810)	80 (50,90)	609 (480,885)	80 (50,90)
15+ Day Supply	750 (540,1080)	90 (60,120)	600 (360,900)	60 (56,100)	720 (480,1080)	90 (60,110)	862.5 (600,1182.5)	90 (60,120)

Supplemental Table 7. Risk difference for prolonged opioid use per 1000 patients and projected number of reduced cases of prolonged opioid use associated with varying day supply limits, stratified by calendar period.

Surgery date between January 1, 2007 - December 31, 2010:						
Day Supply Limit	**Observed Risk/1,000 Above Limit**	**Estimated Risk/1,000 At Limit[a]**	**Risk Difference (95% CI)**	**NNT[b]**	**No. (%) of Surgeries above Cutoff**	**# of Reduced Prolonged Opioid Use Cases[c]**
2[d]	23.72	19.47	4.25 (0.14,8.35)	236	167,944 (90%)	711
3	26.57	19.64	6.92 (4.70,9.14)	145	134,274 (71.9%)	926
4	29.14	24.03	5.11 (2.35,7.87)	196	107,033 (57.3%)	546
5	37.08	29.60	7.48 (5.10,9.87)	134	56,769 (30.4%)	423
6[d]	39.47	35.62	3.84 (-0.27,7.96)	261	44,697 (23.9%)	171
7	43.76	38.79	4.97 (0.35,9.59)	202	30,781 (16.5%)	152
8[d]	46.59	42.04	4.56 (-0.61,9.73)	220	22,084 (11.8%)	100
10	57.45	47.51	9.95 (3.87,16.02)	101	10,200 (5.5%)	100
15[d]	63.93	57.15	6.77 (-7.07,20.62)	148	4,208 (2.3%)	28
Surgery date between January 1, 2011 - December 31, 2014:						
Day Supply Limit	**Observed Risk/1,000 Above Limit**	**Estimated Risk/1,000 At Limit[a]**	**Risk Difference (95% CI)**	**NNT[b]**	**No. (%) of Surgeries above Cutoff**	**# of Reduced Prolonged Opioid Use Cases[c]**
2[e]	21.49	17.60	3.88 (-0.75,8.52)	258	260,871 (92.8%)	1,011
3	23.92	19.12	4.80 (2.45,7.15)	209	215,353 (76.6%)	1,030
4	26.33	22.31	4.02 (1.79,6.25)	249	173,963 (61.9%)	698
5	32.85	27.41	5.44 (3.48,7.39)	184	98,268 (34.9%)	534
6	35.10	26.59	8.50 (5.25,11.76)	118	82,545 (29.3%)	699
7	38.96	35.70	3.26 (0.05,6.46)	307	59,240 (21.1%)	192
8	41.90	36.32	5.58 (1.67,9.48)	180	42,699 (15.2%)	237
10	48.13	42.94	5.18 (0.39,9.97)	194	21,007 (7.5%)	108
15[e]	53.00	48.97	4.03 (-4.54,12.60)	249	8,359 (3%)	33
Surgery date between January 1, 2015 - December 31, 2017:						
Day Supply Limit	**Observed Risk/1,000 Above Limit**	**Estimated Risk/1,000 At Limit[a]**	**Risk Difference (95% CI)**	**NNT[b]**	**No. (%) of Surgeries above Cutoff**	**# of Reduced Prolonged Opioid Use Cases[c]**
2	16.14	10.05	6.08 (4.98,7.19)	165	259,126 (93.5%)	1,570
3	17.97	18.25	-0.28 (-1.26,0.70)	N/A	220,452 (79.5%)	N/A
4	19.94	15.18	4.77 (3.73,5.80)	210	185,964 (67.1%)	885
5	24.15	23	1.15 (-0.05,2.34)	870	116,251 (41.9%)	133
6[f]	25.22	24.8	0.43 (-1.99,2.84)	2326	103,553 (37.4%)	44
7	27.68	27.8	-0.12 (-2.19,1.95)	N/A	77,527 (28%)	N/A
8	29.55	27.71	1.84 (-0.78,4.45)	544	59,730 (21.6%)	109
10	32.50	34.28	-1.79 (-4.67,1.10)	N/A	32,095 (11.6%)	N/A
15	37.19	38.79	-1.60 (-6.37,3.17)	N/A	13,095 (4.7%)	N/A

[a]Risk calculated using g-computation methods 95% confidence intervals based on the standard deviation of 200 bootstrapped resamples, estimating risk of prolonged use if all patients above the limit had instead received a prescription equal to that limit.

[b]NNT: Number needed to treat = RD^{-1}, interpreted as the number of patients needed to be impacted by the limit to reduce one case of prolonged opioid use. Not reported for limits resulting in negative RDs implying an increased risk of prolonged use.

[c]# of Reduced Cases=(# of surgeries above cutoff / NNT)

[d]Among the 200 bootstrapped samples, 5 (2 DS), 2 (6 DS), 27 (8 DS), and 1 (15+ DS) iterations failed to converge in the 2007-2010 analysis.

[e]Among the 200 bootstrapped samples, 4 (2 DS) and 5 (15+DS) iterations failed to converge in the 2011-2014 analysis.

[f]Among the 200 bootstrapped samples, 4 (6 DS) iterations failed to converge in the 2011-2014 analysis.

Supplemental Table 8. Sensitivity analysis excluding patients undergoing surgery in states after prescribing limits had been implemented: Risk difference for prolonged opioid use per 1000 patients and projected number of reduced cases of prolonged opioid use associated with varying day supply limits.

Day Supply Limit	Observed Risk/1,000 Above Limit	Estimated Risk/1,000 At Limit[a]	Risk Difference (95% CI)	NNT[b]	No. (%) of Surgeries above Cutoff	# of Reduced Prolonged Opioid Use Cases[c]
2	20.3	15.56	4.74 (2.37,7.11)	210	668,532 (92.4%)	3,183
3	22.56	17.65	4.91 (3.45,6.37)	203	554,019 (76.6%)	2,729
4	24.77	19.87	4.90 (3.51,6.30)	204	453,665 (62.7%)	2,223
5	30.44	26.13	4.31 (3.12,5.49)	232	263,373 (36.4%)	1,135
6	32.00	27.52	4.49 (2.17,6.81)	222	223,699 (30.9%)	1,007
7	35.11	33.10	2.01 (0.02,4.00)	497	162,764 (22.5%)	327
8	37.32	33.68	3.65 (1.33,5.96)	273	120,780 (16.7%)	442
10	42.30	40.39	1.91 (-0.85,4.67)	523	61,374 (8.5%)	117
15	47.31	45.54	1.78 (-3.20,6.76)	561	24,941 (3.4%)	44

[a]Risk calculated using g-computation methods with 95% confidence intervals based on the standard deviation of 200 bootstrapped resamples, estimating risk of prolonged use if all patients above the limit had instead received a prescription equal to that limit.

[b]NNT: Number needed to treat = RD^{-1}, interpreted as the number of patients needed to be impacted by the limit to reduce one case of prolonged opioid use.

[c]# of Reduced Cases = (# of surgeries above cutoff / NNT)

Supplemental Table 9. Sensitivity analysis controlling for time using 6-month intervals: Risk difference for prolonged opioid use per 1000 patients and projected number of reduced cases of prolonged opioid use associated with varying day supply limits.

Day Supply Limit	Observed Risk/1,000 Above Limit	Estimated Risk/1,000 At Limit[a]	Risk Difference (95% CI)	NNT[b]	No. (%) of Surgeries above Cutoff	# of Reduced Prolonged Opioid Use Cases[c]
2[d]	20.01	15.42	4.59(2.06,7.13)	218	687,941 (92.3%)	3,155
3	22.24	17.45	4.79(3.34,6.24)	209	570,079 (76.5%)	2,727
4	24.43	19.58	4.85(3.60,6.09)	207	466,960 (62.7%)	2,255
5	30.01	25.80	4.21(3.02,5.39)	238	271,288 (36.4%)	1,139
6	31.51	27.14	4.37(2.14,6.61)	229	230,795 (31%)	1,007
7	34.62	32.57	2.05(-0.17,4.27)	488	167,548 (22.5%)	343
8	36.81	32.99	3.82(1.60,6.03)	262	124,513 (16.7%)	475
10	41.70	39.77	1.93(-0.97,4.84)	519	63,302 (8.5%)	121
15	46.72	45.32	1.41(-2.98,5.79)	710	25,662 (3.4%)	36

[a]Risk calculated using g-computation methods with 95% confidence intervals based on the standard deviation of 200 bootstrapped resamples, estimating risk of prolonged use if all patients above the limit had instead received a prescription equal to that limit.

[b]NNT: Number needed to treat = RD^{-1}, interpreted as the number of patients needed to be impacted by the limit to reduce one case of prolonged opioid use.

[c]# of Reduced Cases = (# of surgeries above cutoff / NNT)

[d]Among the 200 bootstrapped samples, 26 (13%) of iterations failed to converge in the 2 day supply exposure level.

Supplemental Table 10. Sensitivity analysis controlling for age using categories: Risk difference for prolonged opioid use per 1,000 patients and projected number of reduced cases of prolonged opioid use associated with varying day supply limits.

Day Supply Limit	Observed Risk/1,000 Above Limit	Estimated Risk/1,000 At Limit[a]	Risk Difference (95% CI)	NNT[b]	No. (%) of Surgeries above Cutoff	# of Reduced Prolonged Opioid Use Cases[c]
2	20.01	15.41	4.61 (2.11,7.10)	217	687,941 (92.3%)	3,170
3	22.24	17.44	4.80 (3.35,6.26)	209	570,079 (76.5%)	2,727
4	24.43	19.57	4.86 (3.61,6.10)	206	466,960 (62.7%)	2,266
5	30.01	25.78	4.22 (3.03,5.41)	237	271,288 (36.4%)	1,144
6	31.51	27.19	4.32 (2.10,6.54)	232	230,795 (31%)	994
7	34.62	32.57	2.05 (-0.15,4.26)	488	167,548 (22.5%)	343
8	36.81	33.12	3.69 (1.46,5.92)	272	124,513 (16.7%)	457
10	41.7	39.53	2.17 (-0.71,5.06)	461	63,302 (8.5%)	137
15	46.72	44.93	1.79 (-2.60,6.17)	559	25,662 (3.4%)	45

[a]Risk calculated using g-computation methods with 95% confidence intervals based on the standard deviation of 200 bootstrapped resamples, estimating risk of prolonged use if all patients above the limit had instead received a prescription equal to that limit.

[b]NNT: Number needed to treat = RD^{-1}, interpreted as the number of patients needed to be impacted by the limit to reduce one case of prolonged opioid use.

[c]# of Reduced Cases = (# of surgeries above cutoff / NNT)

Supplemental Table 11. Sensitivity analysis controlling for age as a quadratic: Risk difference for prolonged opioid use per 1,000 patients and projected number of reduced cases of prolonged opioid use associated with varying day supply limits.

Day Supply Limit	Observed Risk/1,000 Above Limit	Estimated Risk/1,000 At Limit[a]	Risk Difference (95% CI)	NNT[b]	No. (%) of Surgeries above Cutoff	# of Reduced Prolonged Opioid Use Cases[c]
2	20.01	15.42	4.59 (2.09,7.09)	218	687,941 (92.3%)	3,155
3	22.24	17.43	4.81 (3.36,6.27)	208	570,079 (76.5%)	2,740
4	24.43	19.58	4.85 (3.60,6.09)	207	466,960 (62.7%)	2,255
5	30.01	25.82	4.19 (3.00,5.37)	239	271,288 (36.4%)	1,135
6	31.51	27.22	4.29 (2.07,6.52)	234	230,795 (31%)	986
7	34.62	32.59	2.04 (-0.18,4.25)	491	167,548 (22.5%)	341
8	36.81	33.04	3.77 (1.56,5.98)	266	124,513 (16.7%)	468
10	41.7	39.77	1.94 (-0.96,4.84)	516	63,302 (8.5%)	122
15	46.72	45.18	1.54 (-2.81,5.89)	650	25,662 (3.4%)	39

[a]Risk calculated using g-computation methods with 95% confidence intervals based on the standard deviation of 200 bootstrapped resamples, estimating risk of prolonged use if all patients above the limit had instead received a prescription equal to that limit.

[b]NNT: Number needed to treat = RD^{-1}, interpreted as the number of patients needed to be impacted by the limit to reduce one case of prolonged opioid use.

[c]# of Reduced Cases = (# of surgeries above cutoff / NNT)