# Supplemental Information

Table S1. Opioid classes investigated and frequency of prescriptions for CTR.

|  |  |
| --- | --- |
| Opioid Class | N (%) |
| Aspirin/caffeine/dihydrocodeine bitartrate  | 0 (0%) |
| Buprenorphine HCL | 2 (0%) |
| Buprenorphine HCL/naloxon | 2 (0%) |
| Butorphanol tartrate  | 0 (0%) |
| Codeine phosphate  | 0 (0%) |
| Codeine sulfate | 2 (0%) |
| Codeine/acetaminophen  | 366 (6.4%) |
| Fentanyl | 9 (0.2%) |
| Fentanyl citrate oral transmucosal | 0 (0%) |
| Hydrocodone bitartrate  | 0 (0%) |
| Hydrocodone/acetaminophen | 3966 (69.2%) |
| Hydrocodone/ibuprofen | 11 (0.2%) |
| Hydromorphone HCL | 16 (0.3%) |
| Levorphanol tartrate | 0 (0%) |
| Meperidine HCL | 27 (0.5%) |
| Methadone HCL | 1 (0%) |
| Morphine sulfate | 2 (0%) |
| Morphine sulfate ER | 4 (0.1%) |
| Nalbuphine HCL | 0 (0%) |
| Oxycodone HCL | 74 (1.3%) |
| Oxycodone/acetaminophen | 1142 (19.9%) |
| Oxycodone/aspirin | 0 (0%) |
| Oxycodone/ibuprofen | 0 (0%) |
| Oxymorphone hydrochloride | 2 (0%) |
| Pentazocine/naloxon HCL | 14 (0.2%) |
| Tapentadol | 0 (0%) |
| Tramadol HCL | 84 (1.5%) |
| Tramadol hydrochloride AC | 5 (0.1%) |

Table S2. Prevalence of risk factors prior to CTR (90 days prior to CTR procedure) and during the release time frame (seven days before/after CTR procedure)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **All, n = 7,840** | **Not Prescribed Opioid for CTR, n = 2,353** | **Prescribed Opioid for CTR, n = 5,487** | **p.value1** |
| **Depression diagnosis prior to CTR** |  |  |  | 0.059 |
| No | 6,479 (82.6%) | 1,974 (83.9%) | 4,505 (82.1%) |  |
| Yes | 1,361 (17.4%) |  379 (16.1%) |  982 (17.9%) |  |
| **Drug abuse diagnosis prior to CTR** |  |  |  | 1 |
| No | 7,809 (99.6%) | 2,344 (99.6%) | 5,465 (99.6%) |  |
| Yes |  31 (0.4%) |  9 (0.4%) |  22 (0.4%) |  |
| **Alcohol abuse diagnosis prior to CTR** |  |  |  | 0.897 |
| No | 7,814 (99.7%) | 2,346 (99.7%) | 5,468 (99.7%) |  |
| Yes |  26 (0.3%) |  7 (0.3%) |  19 (0.3%) |  |
| **Psychosis diagnosis prior to CTR** |  |  |  | 1 |
| No | 7,830 (99.9%) | 2,350 (99.9%) | 5,480 (99.9%) |  |
| Yes |  10 (0.1%) |  3 (0.1%) |  7 (0.1%) |  |
| **Depression diagnosis during release time frame** |  |  |  | 0.497 |
| No | 7,336 (93.6%) | 2,209 (93.9%) | 5,127 (93.4%) |  |
| Yes |  504 (6.4%) |  144 (6.1%) |  360 (6.6%) |  |
| **Drug abuse diagnosis during release time frame** |  |  |  | 1 |
| No | 7,826 (99.8%) | 2,349 (99.8%) | 5,477 (99.8%) |  |
| Yes |  14 (0.2%) |  4 (0.2%) |  10 (0.2%) |  |
| **Alcohol abuse diagnosis during release time frame** |  |  |  | 0.789 |
| No | 7,834 (99.9%) | 2,352 (100%) | 5,482 (99.9%) |  |
| Yes |  6 (0.1%) |  1 (0%) |  5 (0.1%) |  |
| **Psychosis diagnosis during release time frame** |  |  |  | NA |
| No | 7,840 (100%) | 2,353 (100%) | 5,487 (100%) |  |
| **Benzodiazapine prescription during release time frame** |  |  |  | 0.388 |
| No | 7,800 (99.5%) | 2,338 (99.4%) | 5,462 (99.5%) |  |
| Yes |  40 (0.5%) |  15 (0.6%) |  25 (0.5%) |  |
| 1 p-value from chi-squared test |

Table S3. Frequency of predictor being selected in bootstrap multiple regression backwards selection techniques

|  | Variable Type | Selection Frequency in Duration Model (%) | Selection Frequency in Cost Model (%) |
| --- | --- | --- | --- |
| Age (years) | Numeric | 78 | 26 |
| Alcohol abuse diagnosis during disability time frame | Bernoulli | 10 | 9 |
| Anemia diagnosis during disability time frame | Bernoulli | 36 | 95 |
| Arrhythmia diagnosis during disability time frame | Bernoulli | 20 | 8 |
| Blood loss diagnosis during disability time frame | Bernoulli | 5 | 43 |
| Congestive heart failure diagnosis during disability time frame | Bernoulli | 30 | 54 |
| Coagulopathy diagnosis during disability time frame | Bernoulli | 14 | 17 |
| Depression diagnosis during disability time frame | Bernoulli | 4 | 34 |
| Diabetes, uncomplicated diagnosis during disability time frame | Bernoulli | 72 | 5 |
| Diabetes, complicated diagnosis during disability time frame | Bernoulli | 13 | 10 |
| Drug abuse diagnosis during disability time frame | Bernoulli | 12 | 36 |
| Fluid and electrolyte disorder diagnosis during disability time frame | Bernoulli | 9 | 23 |
| HIV/AIDS diagnosis during disability time frame | Bernoulli | 39 | 3 |
| Hypertension, uncomplicated diagnosis during disability time frame | Bernoulli | 18 | 13 |
| Hypothyroidism diagnosis during disability time frame | Bernoulli | 36 | 3 |
| Liver disease diagnosis during disability time frame | Bernoulli | 33 | 20 |
| Lymphoma diagnosis during disability time frame | Bernoulli | 0 | 0 |
| Other neurological disorders diagnosis during disability time frame | Bernoulli | 11 | 56 |
| Obesity diagnosis during disability time frame | Bernoulli | 6 | 12 |
| Paralysis diagnosis during disability time frame | Bernoulli | 0 | 0 |
| Pulmonary circulation disorders diagnosis during disability time frame | Bernoulli | 31 | 23 |
| Psychoses diagnosis during disability time frame | Bernoulli | 1 | 0 |
| Peptic ulcer disease excluding bleeding diagnosis during disability time frame | Bernoulli | 0 | 1 |
| Pulmonary disease, chronic diagnosis during disability time frame | Bernoulli | 23 | 62 |
| Peripheral vascular disorders diagnosis during disability time frame | Bernoulli | 11 | 1 |
| Renal failure diagnosis during disability time frame | Bernoulli | 10 | 31 |
| Rheumatoid arthritis/ collagen vascular diseases diagnosis during disability time frame | Bernoulli | 25 | 13 |
| Solid tumor without metastasis diagnosis during disability time frame | Bernoulli | 0 | 0 |
| Valvular disease diagnosis during disability time frame | Bernoulli | 20 | 17 |
| Weight loss diagnosis during disability time frame | Bernoulli | 1 | 14 |
| Comorbidity index during disability time frame | Numeric | 40 | 30 |
| Case works in construction industry | Bernoulli | 0 | 0 |
| \*Opioid prescribed according to Guidelines  | Bernoulli | 74 | 99 |
| Case had inpatient stay during disability time frame | Bernouli | 36 | 97 |
| Number of unique ICDs during disability time frame | Numeric | 100 | 100 |
| Number of unique CPTS during disability time frame | Numeric | 100 | 100 |
| Case works in finance insurance real estate industry | Bernoulli | 31 | 78 |
| Sex (male or female) | Categorical | 87 | 10 |
| Case works in manufacturing durable goods industry | Bernoulli | 99 | 89 |
| Case works in manufacturing nondurable goods industry | Bernoulli | 99 | 65 |
| Median household income in geographic area | Numeric (scaled) | 50 | 100 |
| Number of CTR procedures | Numeric | 100 | 100 |
| Case works in oil gas, extraction, mining industry | Bernoulli | 26 | 1 |
| Percent of individuals in geographical area with a college education | Numeric | 95 | 14 |
| Population density in geographical area  | Numeric | 42 | 35 |
| Case has POS health plan | Bernoulli | 0 | 0 |
| Case has PPO health plan | Bernoulli | 6 | 95 |
| Case had a previous disability leave | Bernoulli | 77 | 15 |
| Case had a previous disability leave for CT | Bernoulli | 18 | 8 |
| Case works in retail trade industry | Bernoulli | 70 | 20 |
| Case is a salaried worker | Bernoulli | 100 | 51 |
| Case works in services industry | Bernoulli | 91 | 14 |
| Case works in transportation, communications, utilities industry | Bernoulli | 55 | 89 |
| Case is a union worker | Bernoulli | 100 | 29 |
| \* Exposure of interest |

Table S4. Kaplan-Meier estimations of the difference in disability duration and medical costs by whether the opioid-naïve case was prescribed an opioid according or contrary to ACOEM’s recommendations. Removing cases prescribed any opioids later than the day after the CTR procedure

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Disability Duration (Days)** | **Medical Costs ($)** |
| **N** | **5th %ile** | **25th %ile** | **Median** | **Mean** | **75th %ile** | **95th %ile** | **5th %ile** | **25th %ile** | **Median** | **Mean** | **75th %ile** | **95th %ile** |
| **Opioid According to Guidelines** | 1,369 | 13 | 25 | 40 | 47 | 55 | 99 | 1,677 | 2,850 | 4,057 | 5,279 | 6,053 | 11,370 |
| **Opioid Contrary to Guidelines** | 1,443 | 14 | 27 | 41 | 50 | 59 | 112 | 1,800 | 2,971 | 4,496 | 6,005 | 6,938 | 14,717 |

Table S5. Lognormal survival regression model results quantifying the impact of prescribing opioids contrary to ACOEM’s guidelines on disability duration and medical costs. Removing cases prescribed any opioids later than the day after the CTR procedure (n = 2,812).

|  |  |  |
| --- | --- | --- |
|  | Disability Duration Model (Days) | Medical Cost Model ($) |
| Variable | **β** | **Standard error** | **p-value** | **β** | **Standard error** | **p-value** |
| Intercept | 3.118 | 0.133 | <0.001 | 7.641 | 0.048 | <0.001 |
| Opioid prescribed contrary to Guidelines | - | - | - | 0.088 | 0.021 | <0.001 |
| Sex (male = 1, females = 0) | -0.063 | 0.024 | 0.008 | - | - | - |
| Previous disability program utilization  | 0.059 | 0.022 | 0.008 | - | - | - |
| Number of unique diagnoses during disability  | 0.019 | 0.004 | <0.001 | 0.028 | 0.004 | <0.001 |
| Number of unique procedures during disability  | 0.019 | 0.002 | <0.001 | 0.016 | 0.002 | <0.001 |
| Number of CTR procedures | 0.524 | 0.034 | <0.001 | 0.518 | 0.033 | <0.001 |
| Comorbidities during disability:1 |  |  |  |  |  |  |
| Diabetes mellitus | -0.096 | 0.039 | 0.014 | - | - | - |
| Pulmonary disease | - | - | - | -0.121 | 0.054 | 0.025 |
| Case industry: |  |  |  |  |  |  |
| Manufacturing Durable Goods | 0.09 | 0.027 | 0.001 | -0.18 | 0.035 | <0.001 |
| Manufacturing Nondurable Goods | 0.126 | 0.033 | <0.001 | -0.112 | 0.04 | 0.005 |
| Services | 0.084 | 0.044 | 0.056 | - | - | - |
| Transportation Communications Utilities | - | - | - | -0.172 | 0.035 | <0.001 |
| Finance, insurance, real estate | - | - | - | -0.146 | 0.04 | <0.001 |
| Geographical area variables: |  |  |  |  |  |  |
| Median household income (scaled) | -0.025 | 0.013 | 0.047 | 0.074 | 0.011 | <0.001 |
| Percent of college graduates | -0.518 | 0.21 | 0.014 | - | - | - |
| Health plans: |  |  |  |  |  |  |
| Preferred provider organization plan | - | - | - | -0.06 | 0.022 | 0.007 |
| Consumer-driver health plan | -0.109 | 0.024 | <0.001 | - | - | - |
| Case salaried | -0.271 | 0.029 | <0.001 | 0.075 | 0.027 | 0.005 |
| Case in union  | 0.105 | 0.025 | <0.001 | - | - | - |
| 1 Comorbidity groupings from Quan et al. (2005).  |

Table S6. Comparison of demographic and medical characteristics of STD cases in our sample to non-disability cases with a CTR procedure

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **STD Cases in Sample, n = 7,840** | **Non-Disability Cases with CTR, n = 7,840** | **p.value1** |
| **Sex** |  |  | <0.001 |
| Female | 4,757 (60.7%) | 4,419 (56.4%) |  |
| Male | 3,083 (39.3%) | 3,421 (43.6%) |  |
| **Age (years)** |  |  | <0.001 |
| ≥18 and < 30 |  236 (3%) |  195 (2.5%) |  |
| ≥30 and < 40  | 1,199 (15.3%) |  928 (11.8%) |  |
| ≥40 and < 50  | 2,346 (29.9%) | 2,136 (27.2%) |  |
| ≥50 and < 66  | 4,059 (51.8%) | 4,581 (58.4%) |  |
| **Number of unique diagnoses during release time frame** |  |  | 0.705 |
| 0 |  0 (0%) |  4 (0.1%) |  |
| 1 | 2,136 (27.2%) | 2,142 (27.3%) |  |
| ≥2 and < 4 | 3,256 (41.5%) | 3,285 (41.9%) |  |
| ≥4 and < 22 | 2,448 (31.2%) | 2,409 (30.7%) |  |
| **Number of unique procedures during release time frame** |  |  | <0.001 |
| ≥1 and < 3 | 1,924 (24.5%) | 1,628 (20.8%) |  |
| ≥3 and < 5 | 2,114 (27%) | 2,139 (27.3%) |  |
| ≥5 and < 8 | 1,798 (22.9%) | 1,910 (24.4%) |  |
| ≥8 and < 45 | 2,004 (25.6%) | 2,163 (27.6%) |  |
| **Depression diagnosis prior to CTR** |  |  | 0.001 |
| No | 6,479 (82.6%) | 6,314 (80.5%) |  |
| Yes | 1,361 (17.4%) | 1,526 (19.5%) |  |
| **Opioid prescribed during release time frame** |  |  | <0.001 |
| No | 2,353 (30%) | 2,633 (33.6%) |  |
| Yes | 5,487 (70%) | 5,207 (66.4%) |  |
| **Opioid prescribed contrary to guidelines during release time frame** |  |  | 0.162 |
| No | 5,574 (71.1%) | 5,654 (72.1%) |  |
| Yes | 2,266 (28.9%) | 2,186 (27.9%) |  |
| 1 p-value from chi-squared test |



Figure S1. Time frames used in analysis



Figure S2. Kaplan-Meier curves of percent on disability and medical costs by opioid day supply, cumulative morphine equivalents (ME), and ME (mg) per day.



Figure S3. Yearly differences in disability durations and medical costs by whether opioid guidelines were followed. Error bars represent 95% confidence intervals of the median value from Kaplan-Meier estimations