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

Online Appendix

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Statistical Methods

G-computation was used to estimate the risk of prolonged opioid use at varying levels of initial opioid prescribing, and to estimate the impact of varying prescribing limits. G-computation is executed in multiple steps. We first run a logistic regression among the subset of patients who received a prescription equal to a certain day supply value, modeling the outcome of prolonged opioid use accounting for the predictors listed in the manuscript. This model outputs coefficients for each predictor (Step 1).

To estimate the expected risk of prolonged use associated with that day supply value, these coefficients are applied to the observed covariates in the overall population, producing predicted probabilities of prolonged opioid use for each patient, had they received that day supply (Step 2). The mean predicted probability across the overall population is reported as the expected risk in the overall study population for that day supply value.

To evaluate impacts of prescribing limits, we apply these coefficients to the observed covariates in the subset of patients who received a prescription with a day supply value exceeding the limit (instead of to the overall population). By applying the coefficients calculated among those who received a prescription equal to the limit (step 1) to patients receiving a prescription above the limit (step 2), we estimate the predicted probability of prolonged opioid use had these patients instead received a prescription equal to the limit.

Logistic regression models were run using SAS 9.4, using proc genmod with a logit link and binomial distribution.

Appendix Table 1. Identification of opioid abuse, opioid poisoning, opioid dependence, and naloxone administration

Code	Code Type	Description
Opioid Abuse		
305.5	ICD-9 CM	Nondependent Opioid Abuse
305.5	ICD-9 CM	Nondependent Opioid Abuse Unspecified Use
305.51	ICD-9 CM	Nondependent Opioid Abuse Continuous Use
305.52	ICD-9 CM	Nondependent Opioid Abuse Episodic Use
305.53	ICD-9 CM	Nondependent Opioid Abuse In Remission
F11.10	ICD-10 CM	Opioid abuse, uncomplicated
F11.11	ICD-10 CM	Opioid abuse, in remission
F11.120	ICD-10 CM	Opioid abuse with intoxication
F11.121	ICD-10 CM	Opioid abuse with intoxication delirium
F11.122	ICD-10 CM	Opioid abuse with intoxication with perceptual disturbance
F11.129	ICD-10 CM	Opioid abuse with intoxication
F11.14	ICD-10 CM	Opioid abuse with opioid-induced mood disorder
F11.150	ICD-10 CM	Opioid abuse with opioid-induced psychotic disorder with delusions
F11.151	ICD-10 CM	Opioid abuse with opioid-induced psychotic disorder with hallucinations
F11.159	ICD-10 CM	Opioid abuse with opioid-induced psychotic disorder
F11.181	ICD-10 CM	Opioid abuse with opioid-induced sexual dysfunction
F11.182	ICD-10 CM	Opioid abuse with opioid-induced sleep disorder
F11.188	ICD-10 CM	Opioid abuse with other opioid-induced disorder
F11.19	ICD-10 CM	Opioid abuse with unspecified opioid-induced disorder

Opioid Poisoning		
965.00	ICD-9 CM	Poisoning By Opium (Alkaloids) Unspecified
965.01	ICD-9 CM	Poisoning By Heroin
965.02	ICD-9 CM	Poisoning By Methadone
965.09	ICD-9 CM	Poisoning By Other Opiates And Related Narcotics
970.1	ICD-9 CM	Poison-Opiate Antagonist
E8500	ICD-9 CM	Accidental Poisoning By Heroin
E8501	ICD-9 CM	Accidental Poisoning By Methadone
E8502	ICD-9 CM	Accidental Poisoning By Other Opiates And Related
T40.0X1A	ICD-10 CM	Poisoning by opium
T40.0X1D	ICD-10 CM	Poisoning by opium
T40.0X1S	ICD-10 CM	Poisoning by opium
T40.0X2A	ICD-10 CM	Poisoning by opium
T40.0X2D	ICD-10 CM	Poisoning by opium
T40.0X2S	ICD-10 CM	Poisoning by opium
T40.0X3A	ICD-10 CM	Poisoning by opium
T40.0X3D	ICD-10 CM	Poisoning by opium
T40.0X3S	ICD-10 CM	Poisoning by opium
T40.0X4A	ICD-10 CM	Poisoning by opium
T40.0X4D	ICD-10 CM	Poisoning by opium
T40.0X4S	ICD-10 CM	Poisoning by opium
T40.1X1A	ICD-10 CM	Poisoning by heroin
T40.1X1D	ICD-10 CM	Poisoning by heroin
T40.1X1S	ICD-10 CM	Poisoning by heroin
T40.1X2A	ICD-10 CM	Poisoning by heroin
T40.1X2D	ICD-10 CM	Poisoning by heroin
T40.1X2S	ICD-10 CM	Poisoning by heroin
T40.1X3A	ICD-10 CM	Poisoning by heroin
T40.1X3D	ICD-10 CM	Poisoning by heroin
T40.1X3S	ICD-10 CM	Poisoning by heroin
T40.1X4A	ICD-10 CM	Poisoning by heroin
T40.1X4D	ICD-10 CM	Poisoning by heroin
T40.1X4S	ICD-10 CM	Poisoning by heroin
T40.2X1A	ICD-10 CM	Poisoning by other opioids
T40.2X1D	ICD-10 CM	Poisoning by other opioids
T40.2X1S	ICD-10 CM	Poisoning by other opioids
T40.2X2A	ICD-10 CM	Poisoning by other opioids
T40.2X2D	ICD-10 CM	Poisoning by other opioids
T40.2X2S	ICD-10 CM	Poisoning by other opioids
T40.2X3A	ICD-10 CM	Poisoning by other opioids
T40.2X3D	ICD-10 CM	Poisoning by other opioids
T40.2X3S	ICD-10 CM	Poisoning by other opioids
T40.2X4A	ICD-10 CM	Poisoning by other opioids
T40.2X4D	ICD-10 CM	Poisoning by other opioids
T40.2X4S	ICD-10 CM	Poisoning by other opioids

T40.3X1A	ICD-10 CM	Poisoning by methadone
T40.3X1D	ICD-10 CM	Poisoning by methadone
T40.3X1S	ICD-10 CM	Poisoning by methadone
T40.3X2A	ICD-10 CM	Poisoning by methadone
T40.3X2D	ICD-10 CM	Poisoning by methadone
T40.3X2S	ICD-10 CM	Poisoning by methadone
T40.3X3A	ICD-10 CM	Poisoning by methadone
T40.3X3D	ICD-10 CM	Poisoning by methadone
T40.3X3S	ICD-10 CM	Poisoning by methadone
T40.3X4A	ICD-10 CM	Poisoning by methadone
T40.3X4D	ICD-10 CM	Poisoning by methadone
T40.3X4S	ICD-10 CM	Poisoning by methadone
T40.4X1A	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X1D	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X1S	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X2A	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X2D	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X2S	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X3A	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X3D	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X3S	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X4A	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X4D	ICD-10 CM	Poisoning by other synthetic narcotics
T40.4X4S	ICD-10 CM	Poisoning by other synthetic narcotics
T40.601A	ICD-10 CM	Poisoning by unspecified narcotics
T40.601D	ICD-10 CM	Poisoning by unspecified narcotics
T40.601S	ICD-10 CM	Poisoning by unspecified narcotics
T40.602A	ICD-10 CM	Poisoning by unspecified narcotics
T40.602D	ICD-10 CM	Poisoning by unspecified narcotics
T40.602S	ICD-10 CM	Poisoning by unspecified narcotics
T40.603A	ICD-10 CM	Poisoning by unspecified narcotics
T40.603D	ICD-10 CM	Poisoning by unspecified narcotics
T40.603S	ICD-10 CM	Poisoning by unspecified narcotics
T40.604A	ICD-10 CM	Poisoning by unspecified narcotics
T40.604D	ICD-10 CM	Poisoning by unspecified narcotics
T40.604S	ICD-10 CM	Poisoning by unspecified narcotics
T40.691A	ICD-10 CM	Poisoning by other narcotics
T40.691D	ICD-10 CM	Poisoning by other narcotics
T40.691S	ICD-10 CM	Poisoning by other narcotics
T40.692A	ICD-10 CM	Poisoning by other narcotics
T40.692D	ICD-10 CM	Poisoning by other narcotics
T40.692S	ICD-10 CM	Poisoning by other narcotics
T40.693A	ICD-10 CM	Poisoning by other narcotics
T40.693D	ICD-10 CM	Poisoning by other narcotics
T40.693S	ICD-10 CM	Poisoning by other narcotics
T40.694A	ICD-10 CM	Poisoning by other narcotics
T40.694D	ICD-10 CM	Poisoning by other narcotics

T40.694S	ICD-10 CM	Poisoning by other narcotics
Opioid Dependence		
304.0	ICD-9 CM	Opioid Type Dependence
304.00	ICD-9 CM	Opioid Type Dependence Unspecified Use
304.01	ICD-9 CM	Opioid Type Dependence Continuous Use
304.02	ICD-9 CM	Opioid Type Dependence Episodic Use
304.03	ICD-9 CM	Opioid Type Dependence In Remission
F11.20	ICD-10 CM	Opioid dependence
F11.21	ICD-10 CM	Opioid dependence
F11.220	ICD-10 CM	Opioid dependence with intoxication
F11.221	ICD-10 CM	Opioid dependence with intoxication delirium
F11.222	ICD-10 CM	Opioid dependence with intoxication with perceptual disturbance
F11.229	ICD-10 CM	Opioid dependence with intoxication
F11.23	ICD-10 CM	Opioid dependence with withdrawal
F11.24	ICD-10 CM	Opioid dependence with opioid-induced mood disorder
F11.250	ICD-10 CM	Opioid dependence with opioid-induced psychotic disorder with delusions
F11.251	ICD-10 CM	Opioid dependence with opioid-induced psychotic disorder with hallucinations
F11.259	ICD-10 CM	Opioid dependence with opioid-induced psychotic disorder
F11.281	ICD-10 CM	Opioid dependence with opioid-induced sexual dysfunction
F11.282	ICD-10 CM	Opioid dependence with opioid-induced sleep disorder
F11.288	ICD-10 CM	Opioid dependence with other opioid-induced disorder
F11.29	ICD-10 CM	Opioid dependence with unspecified opioid-induced disorder
Naloxone Administration		
J2310	HCPCS	Injection, naloxone HCl

Appendix Table 2. List of opioids by generic name included in the analysis.

List of Opioids Considered
Codeine
Dextropropoxyphene
Fentanyl
Hydrocodone
Hydromorphone
Meperidine

Morphine	
Oxycodone	
Oxymorphone	
Pentazocine	
Tapentadol	
Tramadol	