

Online supplement**Opioid utilization following lumbar arthrodesis: Trends and factors associated with long-term use**

Cover title: Opioid utilization and lumbar arthrodesis

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Table S1. Coding Definitions (ICD-9-CM codes)			
GROUP	CATEGORY	CODES	NOTES/CODING RULES
Procedure codes	Anterior lumbar interbody fusion (ALIF)	81.06 only	<i>ICD-9 Procedure codes</i>
	Posterior/Transforaminal interbody fusion (P/TLIF)	81.08 only	<i>ICD-9 Procedure codes</i>
	Posterolateral lumbar fusion (PLF)	81.07 only	<i>ICD-9 Procedure codes</i>
	ALIFs + PLFs	Presence of both 81.06 and 81.07	<i>ICD-9 Procedure codes</i>
	Posterior cervical fusion (PCF)	81.03	<i>ICD-9 Procedure codes</i>
Independent categorical variables (covariates)	Age at surgery	<i>≤50 (reference value) vs >50</i>	-
	Gender	<i>Female (reference value), Male</i>	-
	Diabetes mellitus	<i>250.0-250.xx</i>	<i>ICD-9 Diagnosis code</i>
	Depression or Anxiety disorder	<i>266.2x, 296.3x, 300.02</i>	<i>ICD-9 Diagnosis codes</i>
	Osteoporosis	<i>733.30-733.03, 733.09</i>	<i>ICD-9 Diagnosis codes</i>
	Fibromyalgia/myositis	<i>729.1</i>	<i>ICD-9 Diagnosis codes</i>
	Morbid obesity	<i>278.00, 278.01</i>	<i>ICD-9 Diagnosis codes</i>
	Lower back pain	<i>724.2, 724.5</i>	<i>ICD-9 Diagnosis code</i>
	Motor deficits (plegia)	<i>344.0-344.89</i>	<i>ICD-9 Diagnosis code</i>
	Bowel/Bladder dysfunction	<i>787.60, 788.20, 788.29, 788.31-788.33, 788.39, 788.41, 788.61, 788.63-788.65</i>	<i>ICD-9 Diagnosis code</i>
	Alcohol dependence	<i>303.0x, 303.9x</i>	<i>ICD-9 Diagnosis code</i>
	Drug dependence	<i>304.xx</i>	<i>ICD-9 Diagnosis code</i>
	Preoperative narcotic user	<i>Opioid naïve (reference) vs opioid user</i>	-
Outcome/Endpoints	Monthly post-operative opioid prescription filling rates	Primary outcome measure	-
	Factors associated with long-term opioid use (12-month) following ALIF, P/TLIF and PLF	Secondary outcome measure	-

Dilaudid	Hydrocodone-Acetaminophen
Dilaudid-5	Vicodin
Dilaudid-HP	Vicodin ES
Hydromorphone HCL Dosome	Vicodin HP
Hydromorphone HCL ER	Norco
Percoset	Fentanyl
Percodan	Fentanyl citrate
Oxycodone/Acetaminophen	Fentanyl citrate oral TRA
Oxycodone/Apap	Duragesic
Oxycodone/Aspirin	Methadone HCL
Oxycodone/Ibuprofen	Methadone HCL Diskets
Oxycodone HCL	Methadone HCL Intensol
Oxycodone HCL CR	Methadose
Oxycodone HCL ER	Methadose sugar free
Oxycodone APAP	Morphine sulphate
Oxycontin	Morphine sulphate CR
Hydrocodone/Acetaminophen	Morphine sulphate ER
Hydrocodone/Ibuprofen	MS CONTIN

Note: Patients with a history of prescription filling for any of the above listed narcotic drug within 3-months prior to lumbar arthrodesis surgery (ALIF, P/TLIF, PLF or ALIF + PLF) were labelled as an opioid user (OU) in the study cohort.

Table S3. Development of clinical calculator (app) predicting risk of 1-year narcotic usage in patients undergoing lumbar arthrodesis

Based upon the identified risk-factors, we developed an interactive clinical utility tool aka “app” predicting the estimated risk of prolonged narcotic use at 1-year following lumbar arthrodesis (ALIFs, P/TLIFs, or PLFs). We computed the probability (p) for the narcotic prescription filling at 1-year post lumbar fusion using the following relationship:

$$p = \frac{1}{1 + e^{-(\alpha + \sum_{i=1}^n (\beta_i X_i))}}$$

In the above equation,

α = model intercept;

n = number of variables;

β = model coefficient, and defined as the natural logarithm of the odds; and

X assumes value of either 0 or 1 for qualitative variable.

SUPPLEMENTARY FIGURES

Figure S1: Multivariable regression analysis (full model) demonstrating factors associated with 12-month post-operative narcotic use following ALIF (top left-panel), P/TLIF (top right-panel) and PLF (lower left-panel)

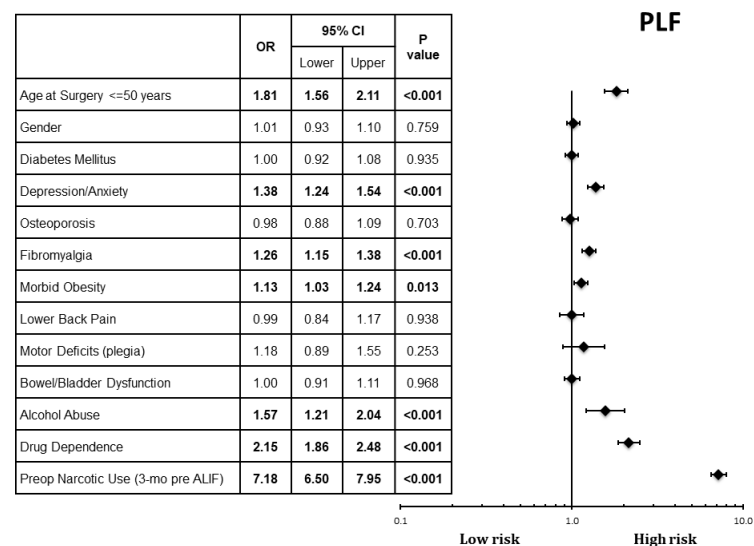
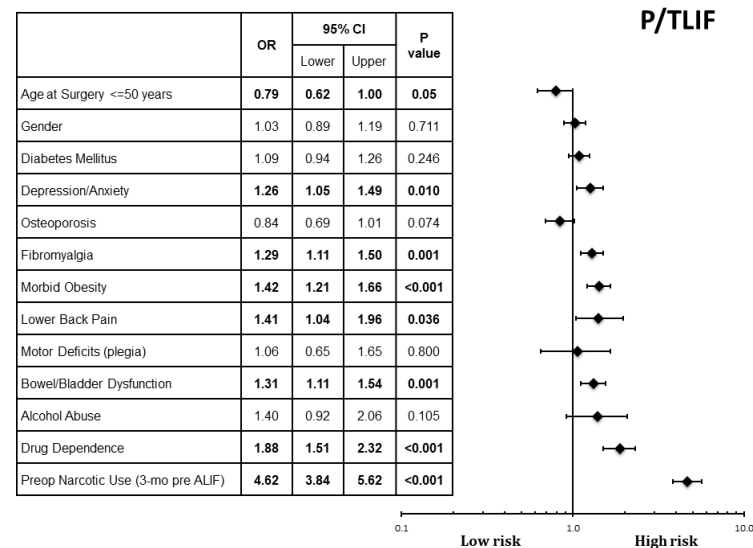
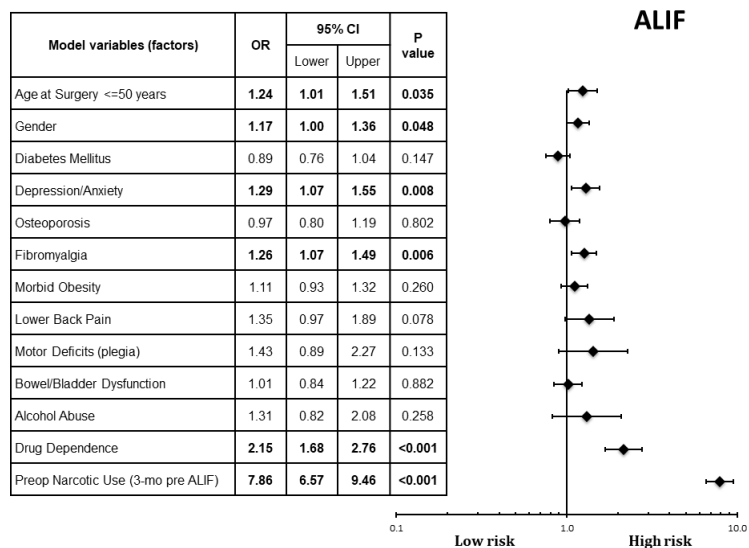


Figure S2: Snapshot of the interactive calculator predicting the estimated risk of 12-month post-operative narcotic use following lumbar arthrodesis

PROBABILITY OF CONTINUED NARCOTIC USE AT 12-MONTH POST-OPERATIVE PERIOD IN PATIENTS UNDERGOING LUMBAR SPINE SURGERY	
To calculate the estimated use of narcotics at 12-month following lumbar spine surgery, complete the following worksheet using the dropdown options:	
Operative Intervention (type)	ALIF
Age at Surgery, in years	>50
Gender	MALE
Diabetes Mellitus	NO
Depression/Anxiety	NO
Osteoporosis	NO
Fibromyalgia	NO
Morbid Obesity	NO
Lower Back Pain	NO
Motor Deficits (plegia)	NO
Bowel/Bladder dysfunction	NO
Alcohol Dependence	NO
Drug Dependence	NO
Preoperative Narcotic Use Within 3 Months Prior to Surgery (Opioid User)	NO
ESTIMATED RISK OF NARCOTIC USE AT 12-MONTH POSTOP	<u>7.23%</u>

Model calibration and application

Based on our findings, we propose an interactive clinical utility tool (app) predicting the estimated risk of prolonged narcotic use at 1-year following lumbar arthrodesis individualized to patient specific characteristics and preoperative narcotic use (Online supplement: Interactive

app). The predicted risk in an opioid naïve elderly male without any predefined comorbidities (DM, osteoporosis back pain, fibromyalgia, morbid obesity, motor deficits, bowel/bladder dysfunction, or depression/anxiety) or history of substance abuse (alcohol or drugs) following ALIF (screenshot above), P/TLIF and PLF is 7.23%, 1.23% and 6.92% at 1-year, respectively. However, in opioid user male (>50 years), the risk of narcotic use at 1-year increases by 5 folds following ALIF or PLF at 38% and 34.82%, and by 4-fold in patients undergoing P/TLIF (5.44%). Presence of comorbidities will increase this risk. All models demonstrated a good calibration with Hosmer-Lemeshow goodness-of-fit test (ALIF: $p=0.308$; P/TLIF: $p=0.837$; PLF: $p=0.223$).