Table S1. Conversions used to standardize doses of opioid medications as morphine equivalents		
Opioid Component	**Components (U.S. Brand Names)**	**Morphine / Opioid Ratio (mg)**
Buprenorphine	Buprenorphine HCl (Subutex)	10/0.4 (25)
	Buprenorphine and naloxone (Suboxone)	
Butorphanol	Butorphanol tartrate (Stadol)	10/2 (5)
Codeine	Codeine and acetaminophen (Tylenol #3, Tylenol #4)	10/75 (0.133)
	Codeine and butalbital	
	Codeine and acetaminophen/butalbital/caffeine (Fioricet)	
	Codeine and aspirin/butalbital/caffeine (ASCOMP, Butalbital compound with codeine, Fiorinal, Fiortal)	
	Codeine, aspirin, and carisoprodol	
Dihydrocodeine	Dihydrocodeine, acetaminophen, caffeine (Panlor DC, Panlor SS)	10/100 (0.1)
Hydrocodone	Hydrocodone and acetaminophen (Lorcet Plus, Lortab, Maxidone, Norco, Vicodin, Vicodin ES, Vicodin HP, Xodol 10/300, Zydone)	10/10 (1)
	Hydrocodone and ibuprofen (Vicoprofen)	
Hydromorphone	Hydromorphone HCl (Dilaudid)	10/2 (5)
Meperidine	Meperidine HCl (Demerol, Meperitab)	10/300 (0.033)
	Meperidine and promethazine (Meprozine)	
Methadone	Methadone HCl (Methadose) dosage	10/2.85 (3.5)
Morphine	Morphine sulphate (Avinza, Kadian, Roxanol)	10/10 (1)
	Opium and belladonna	
Oxycodone	Oxycodone HCl (Oxycontin, OxyIR, Percolone, Roxicodone)	10/15 (0.667)
	Oxycodone and acetaminophen (Endocet, Percocet, Roxicet, Tylox)	
	Oxycodone and aspirin (Endodan, Roxiprin)	
	Oxycodone and ibuprofen (Combunox)	
Oxymorphone	Opana ER	10/6 (1.67)
Propoxyphene	Propoxyphene HCl (Darvon)	10/50 (0.2)
	Propoxyphene HCl and acetaminophen	
	Propoxyphene napsylate and acetaminophen (Balacet 325, Darvocet A500, Darvocet-N 50, Darvocet-N 100, Propacet 100)	
	Propoxyphene, aspirin, and caffeine (Propoxyphene HCl Compound)	

Table S1. Conversions used to standardize doses of opioid medications as morphine equivalents (continued)		
Opioid Component	**Components (U.S. Brand Names)**	**Morphine / Opioid Ratio (mg)**
Tramadol	Tramadol HCl (Ultram, Ultram ER)	10/50 (0.2)
	Tramadol HCl and acetaminophen (Ultracet)	
Fentanyl	**Fentanyl (Duragesic) patch strength**	**Morphine PO equivalent**
	25 μg/hr	97 mg
	37 μg/hr	157 mg
	50 μg/hr	202 mg
	62 μg/hr	246 mg
	75 μg/hr	292 mg
	87 μg/hr	337 mg
	100 μg/hr	359 mg
Abbreviations: ER, extended release; ES, extra strength; HCl, hydrochloride; HP, high potency; PO, per os; U.S., United States.		

SUPPLEMENTAL DIGITAL CONTENT

Table S2. STROBE checklist.			
	Item	**Recommendation**	**Section**
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Abstract
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction
Methods			
Study design	4	Present key elements of study design early in the paper	Methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Methods
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Methods
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods
Bias	9	Describe any efforts to address potential sources of bias	Methods
Study size	10	Explain how the study size was arrived at	Results
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Methods
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Methods
		(b) Describe any methods used to examine subgroups and interactions	Methods
		(c) Explain how missing data were addressed	Methods
		(d) If applicable, explain how loss to follow-up was addressed	Not applicable
		(e) Describe any sensitivity analyses	Not applicable

Table S2. STROBE checklist (continued).			
	Item	**Recommendation**	**Page #**
Results			
Participants	13	(a) Report numbers of individuals at each stage of study—e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Results
		(b) Give reasons for non-participation at each stage	Results
		(c) Consider use of a flow diagram	Not applicable
Descriptive data	14	(a) Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders	Results Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Results Table 1
		(c) Summarise follow-up time (e.g. average and total amount)	Results
Outcome data	15	Report numbers of outcome events or summary measures over time	Results Figure 1
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g. 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Results Figure 2 Table 2-3
		(b) Report category boundaries when continuous variables were categorized	Results Table 1-3
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results
Other analyses	17	Report other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses	Not applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion
Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Disclosure

Table S3. Distributions of clinical traits of kidney transplant recipients by level of posttransplant opioid use					
Baseline Characteristics at the Time of Transplant	**No Use (N=33,329)**	**Level 1 (N=18,603)**	**Level 2 (N=9,628)**	**Level 3 (N=4,175)**	**Level 4 (N=10,452)**
Age, years		‡	‡	‡	‡
<18	9.0	4.0	1.8	1.8	1.8
18 to 30	7.5	9.3	9.4	8.8	8.4
31 to 44	17.4	20.9	22.5	23.4	23.6
45 to 59	34.4	36.4	39.3	40.5	42.4
≥60	31.7	29.4	27.0	25.5	23.8
Female	38.4	39.0	39.5	40.8*	43.1‡
Race		‡	‡	‡	‡
White	53.3	52.6	55.0	55.4	58.2
African-American	23.6	26.4	28.3	30.3	28.4
Hispanic	15.9	14.1	11.4	10.1	9.9
Other	7.3	6.9	5.3	4.1	3.4
Highest level of education		‡	‡	‡	‡
College or higher	44.8	47.2	48.2	46.9	44.1
Grade/high school	43.9	43.3	42.5	44.1	46.6
Missing	11.3	9.5	9.3	9.0	9.3
Employment status		‡	‡	‡	‡
Working	30.8	32.7	32.5	30.4	24.4
Not working	52.8	55.6	57.5	60.2	66.1
Missing	16.4	11.7	10.0	9.4	9.5
Health insurance type		*	*	†	‡
Private	39.1	39.2	39.4	36.4	30.9
Public	60.6	60.7	60.6	63.5	69.0
Missing	0.3	0.1	0.1	0.1	0.1
Body mass index, kg/m^2		‡	‡	‡	‡
<18.5	5.9	3.2	2.6	2.9	3.5
18.5 to 24.9	30.0	30.1	28.0	27.4	27.8
25 to 30	31.0	32.5	32.9	29.9	29.0
>30	29.8	32.0	34.5	37.4	37.1
Missing	3.3	2.3	2.0	2.5	2.7
Physical capacity status		‡	†	†	‡
Not limited	63.8	66.6	65.5	65.5	65.0
Limited	6.1	6.7	6.4	7.1	9.0

Missing	30.1	26.7	28.2	27.4	26.0
Comorbid conditions					
Hypertension	77.6	78.8ɬ	78.4	79.0*	79.9ǂ
Diabetes mellitus	30.8	30.5	30.6	31.5	33.5ǂ
Coronary artery disease	6.0	5.7	5.7	6.2	7.4ǂ
Cerebral vascular disease	2.3	2.2	2.3	2.4	2.7*
PVD	3.3	3.0	3.1	3.8	4.1ǂ
COPD	1.0	1.0	1.1	1.0	1.4 ɬ
Cause of ESRD		ǂ	ǂ	ǂ	ǂ
Hypertension	22.7	22.5	22.1	23.1	24.0
Diabetes mellitus	22.8	24.1	25.3	24.4	23.5
Glomerulonephritis	24.6	25.9	25.9	25.9	24.8
Polycystic kidney disease	9.8	9.9	10.7	9.8	10.0
Other	20.2	17.6	16.1	16.8	17.7
Duration of dialysis, months		*	ɬ	ǂ	ǂ
None (pre-emptive)	20.2	19.2	18.7	15.2	13.3
0.1 to 24	31.4	31.5	31.2	31.3	29.2
25 to 60	30.0	29.8	30.0	31.2	33.7
>60	17.4	18.6	19.0	21.3	23.0
Missing	0.9	0.9	1.0	0.9	0.9
Peak PRA level		ǂ	ǂ	ɬ	ǂ
<10	73.2	70.9	70.2	70.3	68.9
10 to 79	17.3	17.8	19.2	18.7	19.6
≥80	5.9	6.4	6.6	7.0	7.7
Missing	3.6	4.9	4.1	3.9	3.9
HLA mismatches					*
Zero A, B, DR	8.5	8.2	8.3	7.8	8.9
Zero DR	10.9	11.1	11.5	10.8	11.7
Other	80.6	80.7	80.2	81.4	79.4
Previous organ transplant	12.2	13.0*	13.8ǂ	14.8ǂ	16.7ǂ
Era of current transplant			*	*	ɬ
2007 to 2009	34.8	34.4	33.1	33.1	33.4
2010 to 2012	48.1	48.4	48.9	50.6	50.2
2013 to 2015	17.0	17.2	18.0	16.3	16.4
Donor type		*	ɬ		ǂ
Living	38.0	39.3	39.9	37.6	35.8
Deceased (SCD)	43.7	42.5	42.1	43.1	46.0

Deceased (ECD)	9.6	9.2	8.8	9.3	8.6
Deceased (DCD)	8.7	8.9	9.2	10.0	9.6
Cold ischemia time, hours		‡	‡	†	‡
<12	49.0	51.1	51.2	48.6	49.2
13 to 24	30.5	30.2	30.8	32.7	32.9
25 to 36	9.5	8.6	8.4	8.9	9.0
>36	2.8	2.2	2.0	1.8	1.9
Missing	8.2	7.9	7.7	8.1	7.1

Data presented as percentages (%).
*p<0.05–0.002; †p=0.001–0.0002; ‡p<0.0001.
Abbreviations: COPD, chronic obstructive pulmonary disease; DCD, donation after cardiac death; ECD, expanded criteria donor; ESRD, end-stage renal disease; HLA, human leukocyte antigens; PRA, panel reactive antibody; PVD, peripheral vascular disease; SCD, standard criteria donor.

Figure S4. Relative risks of death and graft loss over the first year post-transplant, according to opioid use by pretransplant period.

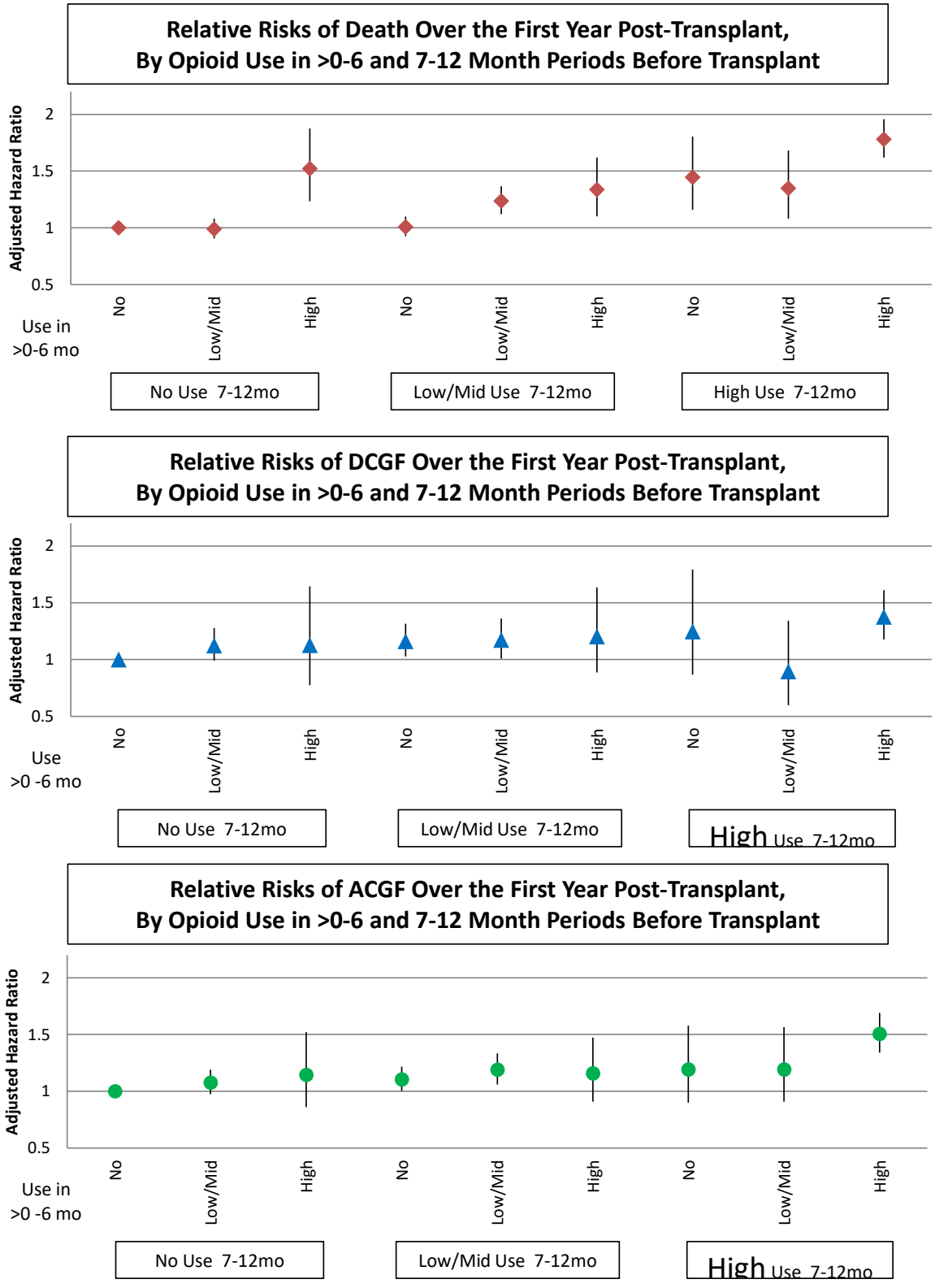

Table S5. Propensity model for associations of baseline factors with pre- and post-transplant opioid use		
Clinical Factor	**Pre-transplant Opioid Use**	**Post-transplant Opioid Use**
Age, years		
<18	0.28 (0.25-0.31)‡	0.28 (0.25-0.31)‡
18 to 30	Reference	Reference
31 to 44	1.05 (0.99-1.12)	1.07 (1.01-1.14)*
45 to 59	0.92 (0.87-0.97)*	0.94 (0.88-1.00)*
≥60	0.66 (0.62-0.70)‡	0.67 (0.63-0.72)‡
Female	1.08 (1.04-1.11)‡	1.07 (1.04-1.11)‡
Race		
White	Reference	Reference
African-American	1.04 (1.00-1.08)*	1.04 (1.01-1.08)*
Hispanic	0.68 (0.64-0.71)‡	0.69 (0.65-0.72)‡
Other	0.67 (0.62-0.71)‡	0.67 (0.63-0.72)‡
Highest level of education		
College or higher	Reference	Reference
Grade/high school	1.07 (1.04-1.11)‡	1.07 (1.04-1.11)‡
Missing	0.94 (0.89-0.99)*	0.94 (0.89-0.99)*
Employment status		
Working	Reference	Reference
Not working	1.19 (1.15-1.23)‡	1.19 (1.15-1.23)‡
Missing	1.08 (1.02-1.15)*	1.08 (1.02-1.15)*
Health insurance type		
Private	Reference	Reference
Public	0.92 (0.89-0.96)‡	0.93 (0.90-0.96)‡
Missing	0.45 (0.31-0.66)‡	0.47 (0.32-0.69)†
Body mass index, kg/m^2		
<18.5	0.87 (0.80-0.94)†	0.87 (0.80-0.95)*
18.5 to 24.9	Reference	Reference
25 to 30	1.03 (0.99-1.07)	1.03 (0.99-1.07)
>30	1.12 (1.08-1.16)‡	1.11 (1.07-1.16)‡
Missing	0.73 (0.66-0.80)‡	0.71 (0.65-0.78)‡
Physical capacity status		

Not limited	Reference	Reference
Limited	1.09 (1.03-1.16)*	1.10 (1.03-1.17)*
Missing	1.02 (0.98-1.06)	1.02 (0.98-1.05)
Comorbid conditions		
Hypertension	0.96 (0.92-1.00)*	0.97 (0.93-1.00)
Diabetes mellitus	1.02 (0.96-1.08)	1.01 (0.96-1.07)
Coronary artery disease	1.03 (0.97-1.09)	1.02 (0.96-1.09)
Cerebral vascular disease	1.00 (0.90-1.10)	0.99 (0.89-1.09)
PVD	0.98 (0.90-1.06)	0.97 (0.89-1.05)
COPD	1.10 (0.95-1.27)	1.08 (0.94-1.25)
Cause of ESRD		
Hypertension	0.96 (0.91-1.01)	0.96 (0.91-1.01)
Diabetes mellitus	0.95 (0.89-1.02)	0.96 (0.89-1.03)
Glomerulonephritis	1.02 (0.97-1.07)	1.02 (0.97-1.07)
Polycystic kidney disease	1.00 (0.94-1.06)	1.00 (0.94-1.07)
Era of current transplant		
2007 to 2009	Reference	Reference
2010 to 2012	1.04 (1.01-1.07)*	1.04 (1.00-1.07)*
2013 to 2015	1.02 (0.98-1.06)	1.02 (0.97-1.07)

Data presented as aOR (95% CI).
*p<0.05–0.002; †p=0.001–0.0002; ‡p<0.0001.
Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; COPD, chronic obstructive pulmonary disease; ESRD, end-stage renal disease; PVD, peripheral vascular disease.

Figure S6. Relative risks of death and graft loss >1 to 6 years post-transplant, according to opioid use in the first year after transplant.