

Supplementary Materials

Supplementary Table S1. List of opioid and psychotropic medication classes

Supplementary Table S2. Clinical Classifications Software (CCS) diagnosis categories used to define principal hospice qualifying diagnosis

Supplementary Table S3. Top 20 psychotropic and opioid medications prescribed among older hospice beneficiaries in the U.S., from 2014-2016 (N=554,022)

Supplementary Table S4. Adjusted prevalence of psychotropic and opioid medication prescribing among older hospice beneficiaries based on principal hospice diagnosis, 2014-2016 (N=554,022)

Supplementary Table S5. Prevalence of psychotropic and opioid medication prescribing among older hospice beneficiaries, overall and by demographics, principal hospice diagnosis, and location of care, restricting to patients with a hospice length of stay >7 days (N=375,550)

Supplementary Table S1. List of opioid and psychotropic medication classes

Medication class	Individual medications
Antidepressants	Amitriptyline, amoxapine, bupropion, citalopram, clomipramine, desipramine, desvenlafaxine, doxepin, duloxetine, escitalopram, fluoxetine, fluvoxamine, imipramine, isocarboxazid, levomilnacipran, maprotiline, milnacipran, mirtazapine, nefazodone, nortriptyline, paroxetine, phenelzine, protriptyline, rasagiline, selegiline, sertraline, tranylcypromine, trazodone, venlafaxine, vilazodone, vortioxetine
Antiepileptics (mood stabilizers)	Carbamazepine, felbamate, gabapentin, lamotrigine, lithium, oxcarbazepine, topiramate, valproate/derivatives
Antipsychotics	Aripiprazole, asenapine, brexpiprazole, cariprazine, chlorpromazine, clozapine, fluphenazine, haloperidol, iloperidone, loxapine, lurasidone, molindone, olanzapine, paliperidone, perphenazine, pimavanserin, pimozide, prochlorperazine, quetiapine, risperidone, thioridazine, thiothixene, trifluoperazine, ziprasidone
Benzodiazepines	Alprazolam, chlordiazepoxide, clobamaz, clonazepam, clorazepate, diazepam, estazolam, flurazepam, halazepam, lorazepam, midazolam, oxazepam, prazepam, quazepam, temazepam, triazolam
Opioids	Buprenorphine, butorphanol, codeine, fentanyl, hydrocodone, hydromorphone, levorphanol, meperidine, methadone, morphine, nalbuphine, opium, oxycodone, oxymorphone, pentazocine, remifentanyl, sufentanyl, tapentadol, tramadol
Other sedative hypnotics	Eszopiclone, zaleplon, zolpidem
Stimulants	Amphetamine, atomoxetine, dexamethylphenidate, dextroamphetamine, lisdexamfetamine, methamphetamine, methylphenidate

Supplementary Table S2. Clinical Classifications Software (CCS) diagnosis categories used to define principal hospice diagnosis

Condition	CCS Diagnosis Categories
Cancer	11-47
Circulatory/heart disease	96-108, 114-121
Dementia	653
Respiratory	127-134
Stroke	109-113
Other	All other CCS categories

Supplementary Table S3. Top 20 psychotropic and opioid medications prescribed among older hospice beneficiaries in the U.S., from 2014-2016 (N=554,022)

Rank	Generic Name	Medication Class	Beneficiaries Prescribed, %	Median Rate of Prescribing per 100 person-days (Q1, Q3) ^a
1	Lorazepam	Benzodiazepine	56.4	7.1 (2.4, 20.0)
2	Morphine	Opioid	52.8	7.1 (2.1, 20.0)
3	Haloperidol	Antipsychotic	28.6	5.3 (1.7, 14.3)
4	Prochlorperazine	Antipsychotic	17.0	4.0 (1.3, 11.1)
5	Hydrocodone ^b	Opioid	10.3	3.7 (1.7, 7.0)
6	Oxycodone ^b	Opioid	7.0	5.3 (2.4, 10.6)
7	Fentanyl	Opioid	6.9	6.9 (3.6, 13.3)
8	Gabapentin	Antiepileptic	5.4	3.9 (2.2, 6.7)
9	Mirtazapine	Antidepressant	5.1	3.6 (2.2, 6.1)
10	Quetiapine	Antipsychotic	5.0	4.1 (2.2, 7.1)
11	Trazodone	Antidepressant	5.0	3.6 (1.9, 6.1)
12	Tramadol	Opioid	5.0	2.8 (1.2, 5.5)
13	Alprazolam	Benzodiazepine	4.8	4.4 (2.1, 8.3)
14	Hydromorphone	Opioid	4.1	12.5 (4.2, 33.3)
15	Sertraline	Antidepressant	4.1	3.7 (2.3, 6.1)
16	Citalopram	Antidepressant	3.7	3.6 (2.0, 5.9)
17	Temazepam	Benzodiazepine	3.5	3.8 (1.9, 6.9)
18	Methadone	Opioid	2.7	6.4 (3.0, 12.0)
19	Risperidone	Antipsychotic	2.5	3.8 (2.1, 6.5)
20	Levetiracetam	Antiepileptics	1.9	4.3 (2.8, 7.9)

^a Rate of prescribing is calculated as number of prescription fills / number of days in hospice per 100-person days. Q1 is 25th percentile, and Q3 is 75th percentile.

^b Includes combination medications (e.g., oxycodone/acetaminophen).

Supplementary Table S4. Adjusted prevalence of psychotropic and opioid medication prescribing among older hospice beneficiaries by principal hospice diagnosis, 2014-2016 (used to generate Figure 1)^a

	Medication Class						
	Opioid	Benzodiazepine	Antipsychotic	Antidepressant	Antiepileptic	Sedative Hypnotic	Stimulant
Principal Hospice Diagnosis	% used given medication class (95% CI)						
Overall	64.3 (64.2, 64.4)	61.2 (61.1, 61.4)	37.9 (37.8, 38.1)	14.2 (14.1, 14.3)	7.9 (7.8, 8.0)	1.3 (1.3, 1.3)	0.1 (0.1, 0.1)
Cancer	72.3 (72.0, 72.5)	66.6 (66.3, 66.8)	44.7 (44.4, 44.9)	11.6 (11.4, 11.8)	7.0 (6.8, 7.1)	1.9 (1.9, 2.0)	0.2 (0.2, 0.2)
Circulatory/Heart Disease	63.5 (63.1, 63.8) ^d	60.9 (60.6, 61.2) ^d	35.9 (35.6, 36.2) ^d	15.1 (14.8, 15.3) ^d	8.4 (8.2, 8.6) ^d	1.6 (1.6, 1.7) ^d	0.1 (0.1, 0.1) ^d
Dementia	57.5 (57.2, 57.8) ^d	57.3 (56.9, 57.6) ^d	38.8 (38.4, 39.1) ^d	17.3 (17.1, 17.6) ^d	8.7 (8.5, 8.9) ^d	0.7 (0.6, 0.7) ^d	0.0 (0.0, 0.0) ^d
Respiratory	62.2 (61.8, 62.6) ^d	60.4 (60.0, 60.9) ^d	31.5 (31.1, 31.9) ^d	14.7 (14.4, 15.0) ^d	7.0 (6.8, 7.1)	1.6 (1.5, 1.7) ^d	0.1 (0.1, 0.1) ^d
Stroke	59.3 (58.9, 59.8) ^d	57.3 (56.9, 57.8) ^d	33.9 (33.4, 34.3) ^d	14.9 (14.6, 15.2) ^d	10.1 (9.9, 10.4) ^d	0.8 (0.8, 0.9) ^d	0.1 (0.0, 0.1) ^d
Other	61.0 (60.6, 61.3) ^d	58.4 (58.0, 58.7) ^d	34.5 (34.2, 34.9) ^d	14.4 (14.2, 14.7) ^d	7.4 (7.2, 7.6) ^d	1.1 (1.0, 1.2) ^d	0.1 (0.1, 0.1) ^d

CI, confidence interval.

^a Logistic regression was used to examine if the prevalence of use of a given medication class differed for a given principal hospice diagnosis group compared to cancer (the reference group); all variables adjusted for sex, age, race and ethnicity, rurality, principal hospice diagnosis, medical comorbidity, length of hospice enrollment, and type of Medicare coverage. For example, prevalence of opioid prescribing was lower among those with a principal hospice diagnosis of dementia compared to those with a principal hospice diagnosis of cancer (57.5% vs 72.3%, respectively). To compute the adjusted prevalence, we set all variables to their mean value.

^b p<0.05; ^c p<0.01; ^d p<0.001.

Supplementary Table S5. Prevalence of psychotropic and opioid medication prescribing, overall and by demographics and principal hospice diagnosis, restricting to patients with a hospice length of stay >7 days (N=375,550)

Demographics	Opioids		Benzodiazepines		Antipsychotics		Antidepressants		Antiepileptics	
	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)	%	AOR (95% CI)
All	70.2		66.9		45.7		25.6		14.0	
Sex										
Female	69.8	1 (ref)	66.6	1 (ref)	44.9	1 (ref)	27.4	1 (ref)	14.5	1 (ref)
Male	70.7	0.97 (0.95,0.99) ^c	67.4	0.99 (0.98,1.01)	47.1	1.08 (1.06,1.10) ^c	22.9	0.86 (0.85,0.88) ^c	13.4	0.91 (0.88,0.93) ^c
Age										
65-74	74.8	1.21 (1.17,1.24) ^c	70.2	1.18 (1.15,1.22) ^c	48.7	1.18 (1.15,1.21) ^c	25.4	1.43 (1.40,1.46) ^c	18.8	2.37 (2.29,2.46) ^c
75-84	71.3	1.10 (1.08,1.13) ^c	67.8	1.09 (1.07,1.11) ^c	46.9	1.11 (1.09,1.13) ^c	26.3	1.26 (1.24,1.28) ^c	15.5	1.64 (1.59,1.69) ^c
85 +	67.7	1 (ref)	65.1	1 (ref)	43.9	1 (ref)	25.3	1 (ref)	11.3	1 (ref)
Rurality										
Urban	70.2	1 (ref)	67.2	1 (ref)	46.8	1 (ref)	25.9	1 (ref)	14.1	1 (ref)
Rural	72.7	1.08 (1.04,1.11) ^c	67.0	0.95 (0.92,0.98) ^c	40.3	0.76 (0.74,0.78) ^c	24.3	0.90 (0.88,0.93) ^c	13.6	0.95 (0.91,0.99) ^b
Race/Ethnicity										
Non-Hispanic white	71.0	1 (ref)	68.0	1 (ref)	46.4	1 (ref)	26.6	1 (ref)	14.0	1 (ref)
Non-Hispanic black	64.7	0.74 (0.71,0.76) ^c	58.0	0.64 (0.62,0.66) ^c	39.8	0.73 (0.71,0.76) ^c	18.1	0.59 (0.57,0.61) ^c	15.1	1.02 (0.98,1.07)
Hispanic	60.2	0.74 (0.69,0.79) ^c	60.6	0.81 (0.76,0.87) ^c	42.4	0.92 (0.87,0.99) ^b	23.1	0.85 (0.80,0.90) ^c	14.1	1.00 (0.91,1.10)
Other	66.5	0.79 (0.75,0.84) ^c	61.7	0.74 (0.71,0.78) ^c	44.7	0.89 (0.85,0.94) ^c	18.1	0.60 (0.57,0.63) ^c	11.5	0.76 (0.70,0.83) ^c
Principal Hospice Diagnosis										
Cancer	77.7	1 (ref)	71.0	1 (ref)	50.5	1 (ref)	18.9	1 (ref)	12.3	1 (ref)
Circulatory/heart disease	69.8	0.64 (0.62,0.66) ^c	66.9	0.79 (0.77,0.82) ^c	43.1	0.72 (0.70,0.74) ^c	26.8	1.39 (1.36,1.43) ^c	14.0	1.26 (1.21,1.31) ^c
Dementia	62.3	0.45 (0.44,0.46) ^c	61.9	0.63 (0.61,0.65) ^c	46.1	0.80 (0.78,0.82) ^c	31.5	1.61 (1.57,1.65) ^c	15.1	1.26 (1.22,1.31) ^c
Respiratory	73.1	0.72 (0.70,0.75) ^c	71.6	0.95 (0.92,0.99) ^b	42.1	0.66 (0.64,0.68) ^c	29.9	1.49 (1.45,1.54) ^c	15.1	1.12 (1.07,1.17) ^c
Stroke	64.5	0.52 (0.50,0.54) ^c	62.3	0.67 (0.64,0.69) ^c	42.5	0.71 (0.69,0.74) ^c	27.4	1.49 (1.44,1.53) ^c	17.6	1.62 (1.54,1.70) ^c
Other	67.4	0.58 (0.56,0.60) ^c	64.8	0.73 (0.71,0.76) ^c	42.9	0.72 (0.70,0.74) ^c	26.1	1.42 (1.39,1.46) ^c	13.5	1.16 (1.11,1.21) ^c
Medical Comorbidity (Number of Diagnoses)										
1-3	67.9	1 (ref)	65.1	1 (ref)	44.1	1 (ref)	25.5	1 (ref)	13.9	1 (ref)
4-6	71.1	1.17 (1.14,1.20) ^c	67.7	1.13 (1.11,1.16) ^c	47.3	1.15 (1.13,1.18) ^c	24.7	1.01 (0.99,1.03)	13.5	1.00 (0.97,1.03)
7+	73.3	1.34 (1.31,1.37) ^c	69.3	1.24 (1.21,1.26) ^c	47.4	1.18 (1.16,1.21) ^c	26.4	1.14 (1.12,1.16) ^c	14.6	1.13 (1.10,1.17) ^c
Length of Hospice Enrollment										
< 1 month	66.3	1 (ref)	63.3	1 (ref)	40.5	1 (ref)	12.2	1 (ref)	7.6	1 (ref)
1-3 months	71.9	1.35 (1.32,1.38) ^c	67.5	1.22 (1.20,1.25) ^c	47.9	1.38 (1.35,1.41) ^c	28.2	2.82 (2.76,2.88) ^c	15.4	2.25 (2.18,2.33) ^c
> 3 months	73.8	1.71 (1.67,1.75) ^c	71.3	1.59 (1.55,1.62) ^c	50.8	1.65 (1.62,1.69) ^c	41.3	4.91 (4.81,5.01) ^c	21.5	3.47 (3.36,3.58) ^c
Medicare Coverage										
Medicare Advantage	70.4	1 (ref)	67.8	1 (ref)	47.7	1 (ref)	25.4	1 (ref)	14.2	1 (ref)
Fee-For-Service	70.1	0.96 (0.94,0.98) ^c	66.5	0.92 (0.90,0.94) ^c	44.7	0.88 (0.87,0.90) ^c	25.6	0.99 (0.97,1.01)	13.9	1.01 (0.99,1.04)

AOR, adjusted odds ratio; CI, confidence interval

^a p<0.05; ^b p<0.01; ^c p<0.001. P-value corresponds to test examining if use differed from the reference group, adjusting for sex, age, race/ethnicity, rurality, principal hospice diagnosis, medical comorbidity, length of hospice enrollment, and type of Medicare coverage.