SUPPLEMENTARY MATERIAL

Supplemental Methods S1

ED visits were identified from inpatient and outpatient claims by the following revenue center codes: 0450-0459 or 0981. For each visit, we identified the principal diagnosis. For visits resulting in admission, we used the principal admission diagnosis rather than the principal discharge diagnosis in order to better reflect the working diagnosis of the emergency physician at the time of admission, rather than the final diagnosis at the end of the hospitalization (which could include complications unrelated to ED care.) The principal diagnosis International Classification of Diseases (ICD) ninth or tenth revision codes were classified into Healthcare Cost and Utilization Project Clinical Classification Software (HCUP-CCS) single-level categories.

Characteristics of the 20% Sample

For outpatient encounters, such as ED visits, a random 20% sample is provided by the Centers for Medicare and Medicaid Services to researchers (compared to the 100% file sample available for inpatient claims). Characteristics of the 20% and 100% samples for those ages 65 and older enrolled in Medicare Parts A and B is shown below.

		2012		2018	
		20% Sample	**100% Sample**	**20% Sample**	**100% Sample**
N		4,570,974	22,857,499	4,707,630	23,520,400
Age, mean (SD) in years		77.8	77.8	77.2	77.2
Age range (years), %	68-74	1,867,216 (40.9%)	9,340,398 (40.9%)	2,098,994 (44.6%)	10,482,866 (44.6%)
	75-79	985,340 (21.6%)	4,918,047 (21.5%)	1,039,051 (22.1%)	5,194,318 (22.1%)
	80-84	790,774 (17.3%)	3,958,054 (17.3%)	725,732 (15.4%)	3,624,106 (15.4%)
	85 and older	927,644 (20.2%)	4,641,000 (20.3%)	843,853 (17.9%)	4,219,110 (17.9%)
Female, %		2639618 (57.7%)	13,201,508 (57.8%)	2,654,302 (56.4%)	13,275,216 (56.4%)
Race, %	Asian	830,011 (1.8%)	416,665 (1.8%)	92,787 (2.0%)	466,077 (2.0%)

	Black	339,729 (7.4%)	1,699,203 (7.4%)	328,801 (7.0%)	1,640,636 (7.0%)
	Hispanic	74,950 (1.6%)	375,317 (1.6%)	70,185 (1.5%)	350,953 (1.5%)
	North American Native	18,791 (0.4%)	94,703 (0.4%)	22,054 (0.5%)	110,297 (0.5%)
	White	3,979,403 (87.1%)	19,894,898 (87.0%)	4,035,516 (85.7%)	20,162,738 (85.7%)
	Other	67,917 (1.5%)	340, 684 (1.5%)	82,194 (1.8%)	410,509 (1.8%)
	Unknown	7,173 (0.2%)	36,028 (0.2%)	76,093 (1.6%)	379,188 (1.6%)
Medicaid Eligible, %		697,128 (15.3%)	3,489,750 (15.3%)	591,309 (12.6%)	2,954,562 (12.6%)
Comorbidity, %	Congestive Heart Failure	711,438 (15.6%)	3,559,094 (15.6%)	643,466 (13.7%)	3,212,357 (13.7%)
	Chronic Kidney Disease	677,401 (14.8%)	3,392,703 (14.8%)	1,122,738 (23.9%)	5,603,206 (23.8%)
	COPD	505,461 (11.1%)	2,534,403 (11.1%)	520085 (11.1%)	2,594,242 (11.0%)
	AD/ADRD	529,692 (11.6%)	265,223 (11.6%)	525,021 (11.2%)	2,626,477 (11.2%)
	Acute Myocardial Infarction	34,884 (0.8%)	174,526 (0.8%)	36,890 (0.8%)	184,366 (0.8%)

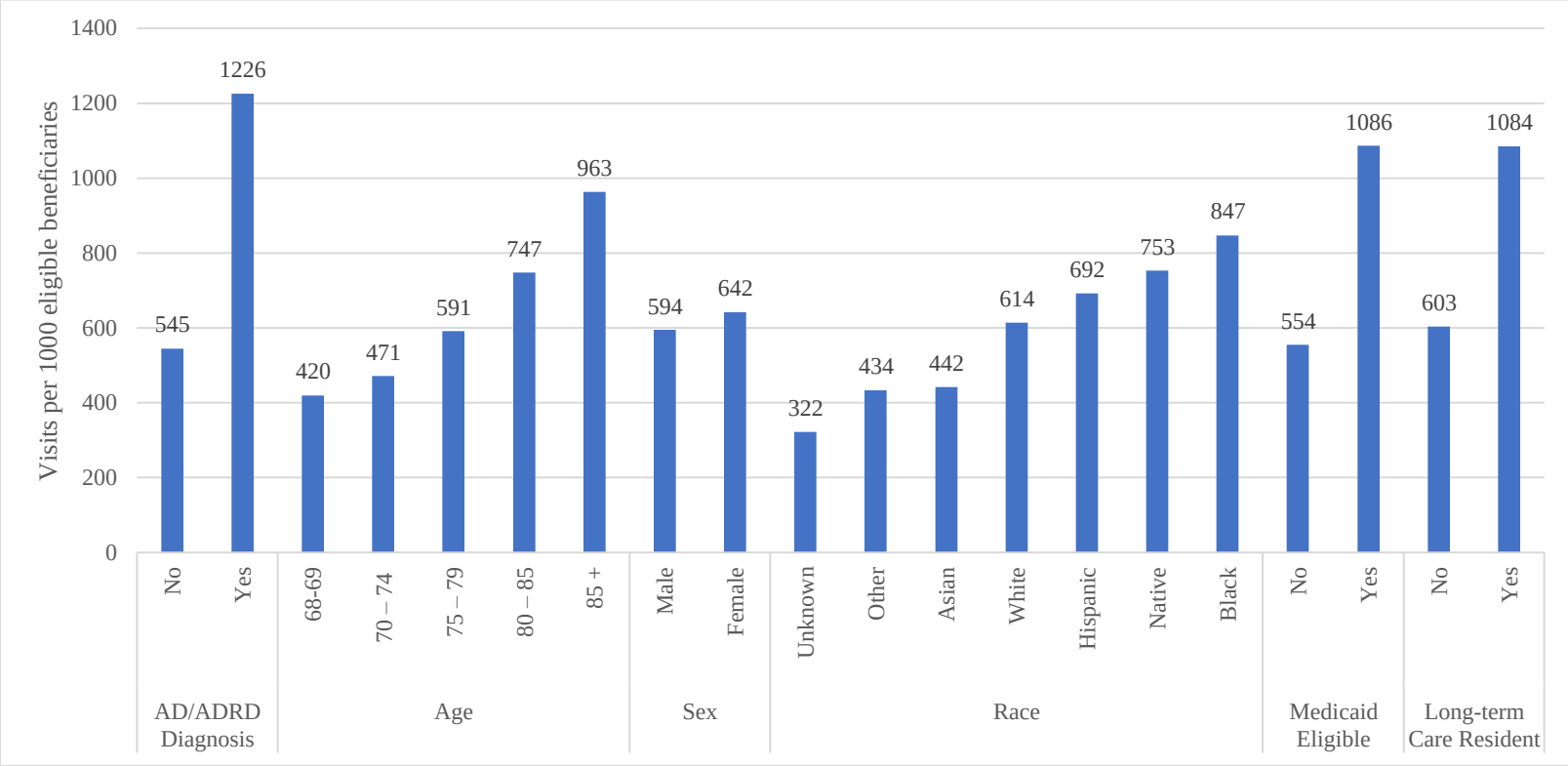
Identification of Beneficiary Nursing Home Residency Status

The method described by Yun et al (Health Serv Outcomes Red Method (2010): 10: 100-110) was used. This method examines Skilled Nursing Facility (SNF) claims and Medicare professional service (Carrier) claims. First, we examine the SNF and Carrier claims file to see if the beneficiary had a SNF claim, a nursing facility care CPT code or place of service code (31-33). If there were no such claims, the beneficiary was deemed as not a nursing facility resident. If the beneficiary always has a SNF facility claim, they were classified as a short stay resident. If the beneficiary had a professional service claim for a SNF place of service code or a nursing facility care CPT code but did NOT have a SNF claim, they were classified as a nursing home resident.

CPT codes used to identify care in a nursing facility are follows (these were updated from the Yun at al paper to reflect changes in codes over time):

99301-99303
99304-99306
99311-99313
99307-99310
99315-99316
99379-99380
99318

Supplemental Figure S2. Rates of ED utilization per 1,000 eligible beneficiaries* overall and stratified by beneficiary characteristics in 2018



*A random 20% sample of beneficiaries age 68 and older continuously enrolled in Medicare parts A and B.

Supplemental Table S3. Ten most frequent principal diagnosis categories* among emergency department (ED) visits and admissions for beneficiaries with and without AD/ADRD in 2012 versus 2018

2A. All ED Visits			
2012		**2018**	
AD/ADRD	**No AD/ADRD**	**AD/ADRD**	**No AD/ADRD**
Unclassified (N=31334; 5.3%)	Chest pain (N=132336; 6.3%)	Urinary tract infection (N=31864; 5.3%)	Chest pain (N=108396; 5.2%)
Urinary tract infection (N=29656; 5.1%)	Other lower respiratory tract disease (N=107958; 5.1%)	Unclassified (N=31560; 5.3%)	Other lower respiratory tract disease (N=96633; 4.6%)
Other lower respiratory tract disease (N=27503; 4.7%)	Abdominal pain (N=81015; 3.8%)	Other lower respiratory tract disease (N=25632; 4.3%)	Urinary tract infection (N=68383; 3.3%)
Superficial injury (N=27437; 4.7%)	Superficial injury (N=71076; 3.4%)	Superficial injury (N=24917; 4.2%)	Superficial injury (N=66605; 3.2%)
Chest pain (N=24911; 4.3%)	Urinary tract infection (N=63092; 3%)	Chest pain (N=21429; 3.6%)	Abdominal pain (N=66012; 3.2%)
Pneumonia (N=19315; 3.3%)	Dysrhythmia (N=61495; 2.9%)	Other injury (N=19765; 3.3%)	Dysrhythmia (N=64108; 3.1%)
Other injury (N=19113; 3.3%)	COPD (N=55178; 2.6%)	Septicemia (N=18444; 3.1%)	Back problem (N=56192; 2.7%)
Syncope (N=18329; 3.1%)	Syncope (N=54915; 2.6%)	Fatigue (N=18443; 3.1%)	COPD (N=50366; 2.4%)
Fatigue (N=15990; 2.7%)	Back problem (N=53098; 2.5%)	Pneumonia (N=14853; 2.5%)	Unclassified (N=49235; 2.3%)
Abdominal pain (N=15243; 2.6%)	Pneumonia (N=50226; 2.4%)	Syncope (N=14766; 2.5%)	Fatigue (N=45542; 2.2%)
2B. Admissions Only			
2012		**2018**	
AD/ADRD	**No AD/ADRD**	**AD/ADRD**	**No AD/ADRD**
Unclassified (N=20179; 8.1%)	Other lower respiratory tract disease (N=71853; 9.6%)	Unclassified (N=19628; 8.2%)	Other lower respiratory tract disease (N=63797; 9.6%)
Other lower respiratory tract disease (N=19267; 7.7%)	Chest pain (N=45773; 6.1%)	Other lower respiratory tract disease (N=18433; 7.7%)	Septicemia (N=32147; 4.8%)
Pneumonia (N=14732; 5.9%)	Pneumonia (N=34316; 4.6%)	Septicemia (N=16665; 7%)	Chest pain (N=25792; 3.9%)
Urinary tract infection (N=12096; 4.8%)	Abdominal pain (N=32248; 4.3%)	Urinary tract infection (N=10592; 4.4%)	Unclassified (N=24552; 3.7%)

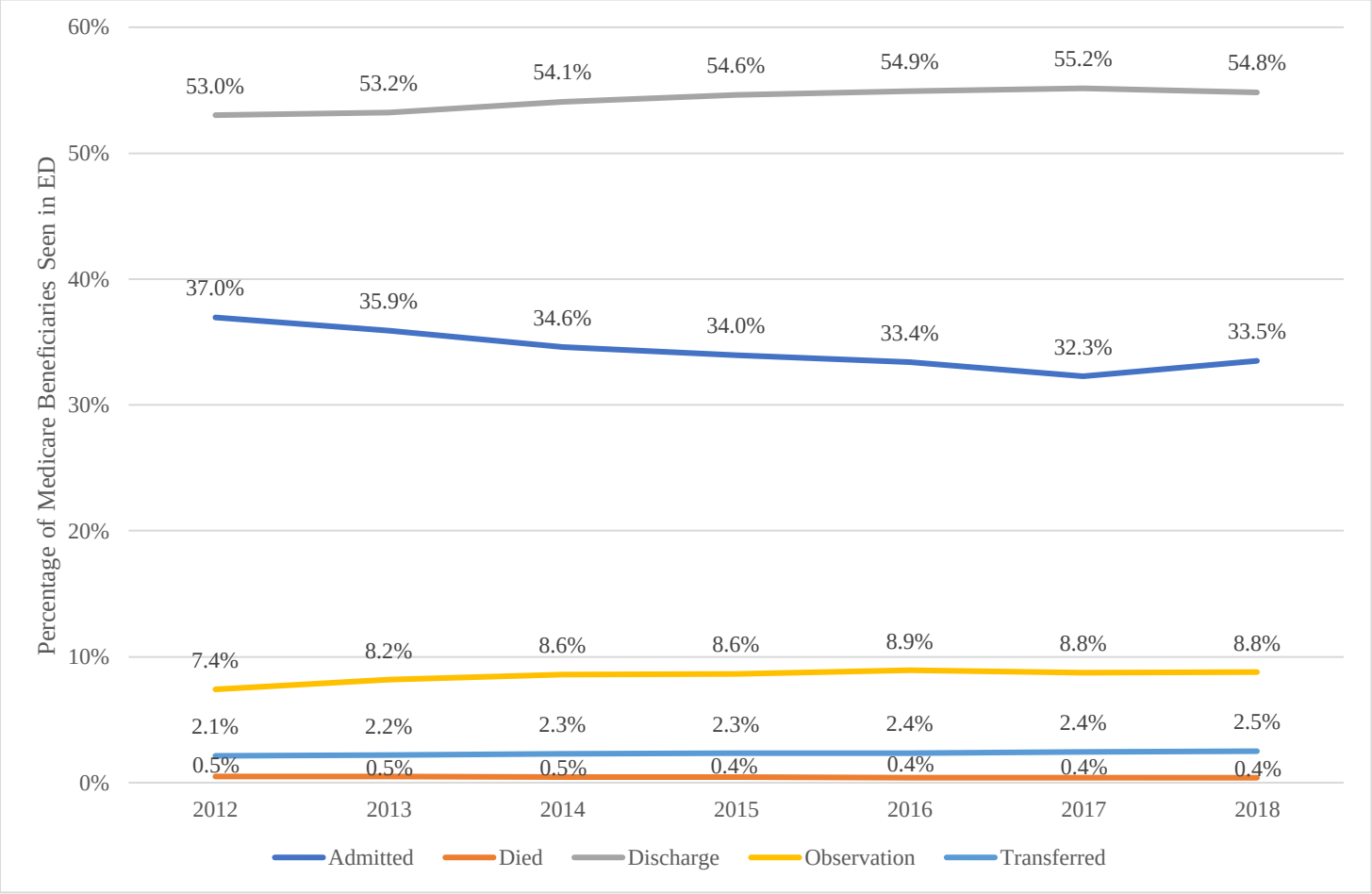
Syncope (N=9695; 3.9%)	CHF; nonhypertensive (N=29851; 4%)	Pneumonia (N=10036; 4.2%)	Fatigue (N=24258; 3.7%)
Septicemia (N=9522; 3.8%)	Dysrhythmia (N=28096; 3.8%)	Fatigue (N=9924; 4.2%)	Dysrhythmia (N=23855; 3.6%)
Chest pain (N=9130; 3.7%)	Gastrointestinal hemorrhage (N=26458; 3.5%)	Gastrointestinal hemorrhage (N=6727; 2.8%)	Pneumonia (N=23503; 3.5%)
Fatigue (N=8396; 3.4%)	Syncope (N=26082; 3.5%)	Hip fracture (N=6688; 2.8%)	Abdominal pain (N=23479; 3.5%)
Gastrointestinal hemorrhage (N=8230; 3.3%)	Unclassified (N=25886; 3.5%)	Fluid/electrolyte disorders (N=6483; 2.7%)	Gastrointestinal hemorrhage (N=21636; 3.3%)
CHF; nonhypertensive (N=7753; 3.1%)	Fatigue (N=24037; 3.2%)	Syncope (N=5811; 2.4%)	CHF; nonhypertensive (N=17608; 2.6%)

*Agency for Healthcare Quality and Research Healthcare Utilization Project Clinical Classifications Categories, Single-Level Diagnosis Categories

Supplemental Table S4. Unadjusted Healthy Days at Home (2017-2018) and Components by Beneficiary Characteristics

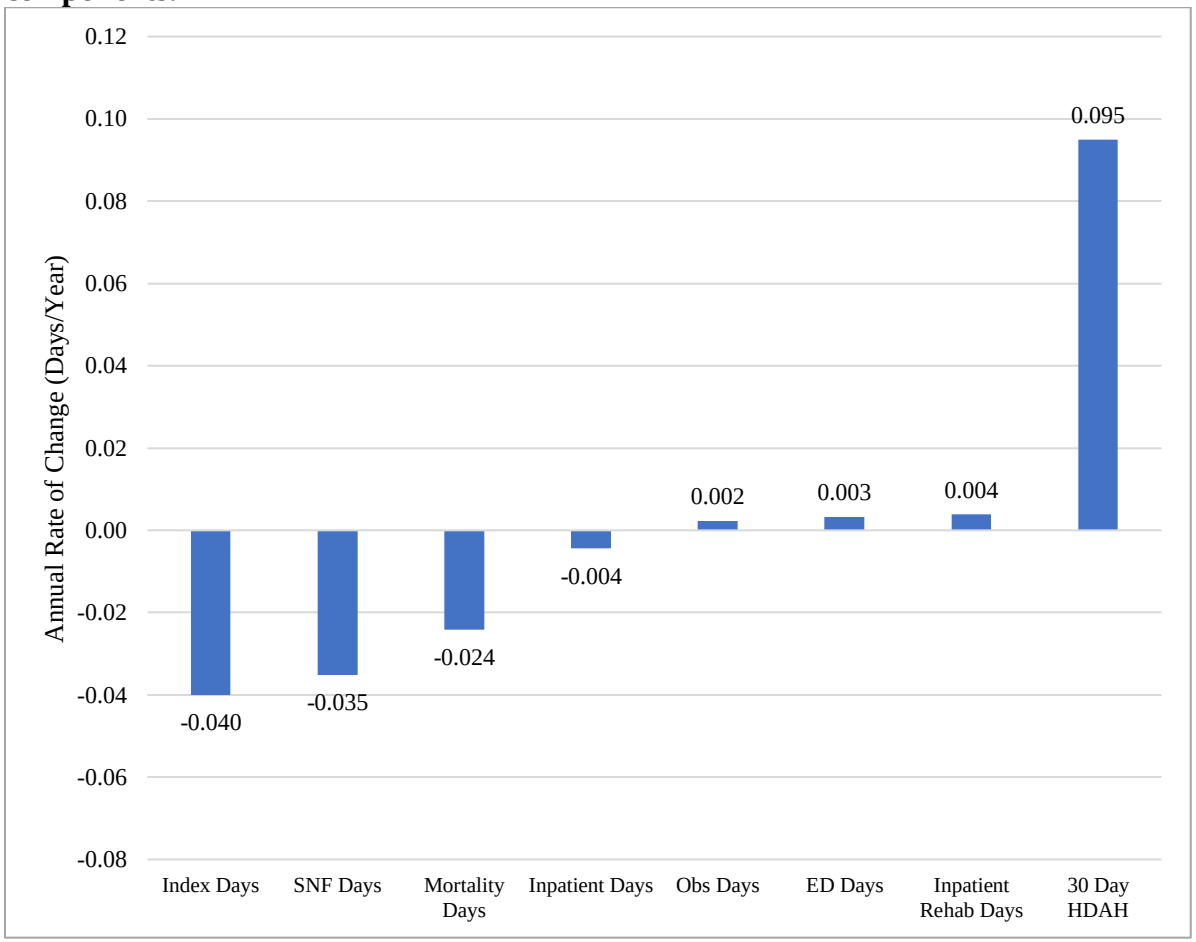
	Number of Visits	Index Visit Days	Mortality Days	SNF Days	Inpatient Days	LTAC Days	Observation Days	Outpatient ED Days	Inpatient rehab	Inpatient Psychiatry Days	Total HDAH
All Visits	5,655,717	2.8	1.0	2.4	1.0	0.066	0.08	0.17	0.27	0.08	22.4
AD/ADRD diagnosis											
Yes	1,241,146	3.2	1.5	4.2	1.1	0.099	0.10	0.21	0.25	0.18	19.5
No	4,415,121	2.7	0.9	1.9	0.9	0.06	0.08	0.16	0.28	0.05	23.3
Age											
68-74	1,842,134	2.6	0.7	1.3	1.0	0.072	0.08	0.20	0.21	0.10	24.0
75 – 79	1,177,302	2.8	0.8	1.9	1.0	0.076	0.08	0.18	0.28	0.08	23.0
80 – 85	1,046,034	2.9	1.1	2.6	1.0	0.066	0.09	0.17	0.32	0.07	22.1
85 +	1,191,244	3.0	1.6	3.8	0.9	0.052	0.08	0.15	0.31	0.06	20.4
Sex											
Male	2,352,930	2.9	1.2	2.1	1.1	0.077	0.08	0.19	0.28	0.08	22.3
Female	3,303,787	2.7	0.9	2.6	0.9	0.058	0.08	0.17	0.26	0.08	22.5
Race											
White	4,798,740	1.0	1.0	2.4	1.0	0.058	0.08	0.17	0.28	0.08	22.4
Black	544,263	0.9	0.9	2.3	1.0	0.120	0.10	0.23	0.22	0.08	22.2
Other	67,285	1.0	1.0	1.9	0.9	0.066	0.07	0.15	0.25	0.06	22.9
Asian	78,287	1.2	1.2	2.2	0.9	0.094	0.06	0.13	0.24	0.04	22.2
Hispanic	94,545	0.9	0.9	1.8	0.9	0.131	0.08	0.20	0.23	0.05	22.9
Native	31,790	1.0	1.0	1.8	1.2	0.080	0.11	0.31	0.19	0.07	22.9
Unknown	41,807	0.6	0.6	1.2	0.8	0.053	0.07	0.16	0.22	0.07	24.4
Nursing Home Resident											
Yes	383,463	1.2	2.2	5.6	1.1	0.14	0.08	0.19	0.13	0.18	17.4
No	5,271,254	1.0	0.9	2.2	1.0	0.06	0.08	0.17	0.28	0.07	22.8
Medicaid Eligible											
Yes	1,262,743	2.2	1.2	3.7	1.2	0.12	0.11	0.25	0.20	0.14	20.4
No	4,393,974	0.9	1.0	2.0	0.9	0.05	0.08	0.15	0.29	0.06	23.0

Supplemental Figure S5. Trends in disposition* among Medicare beneficiaries seen in the emergency department from 2011-2018



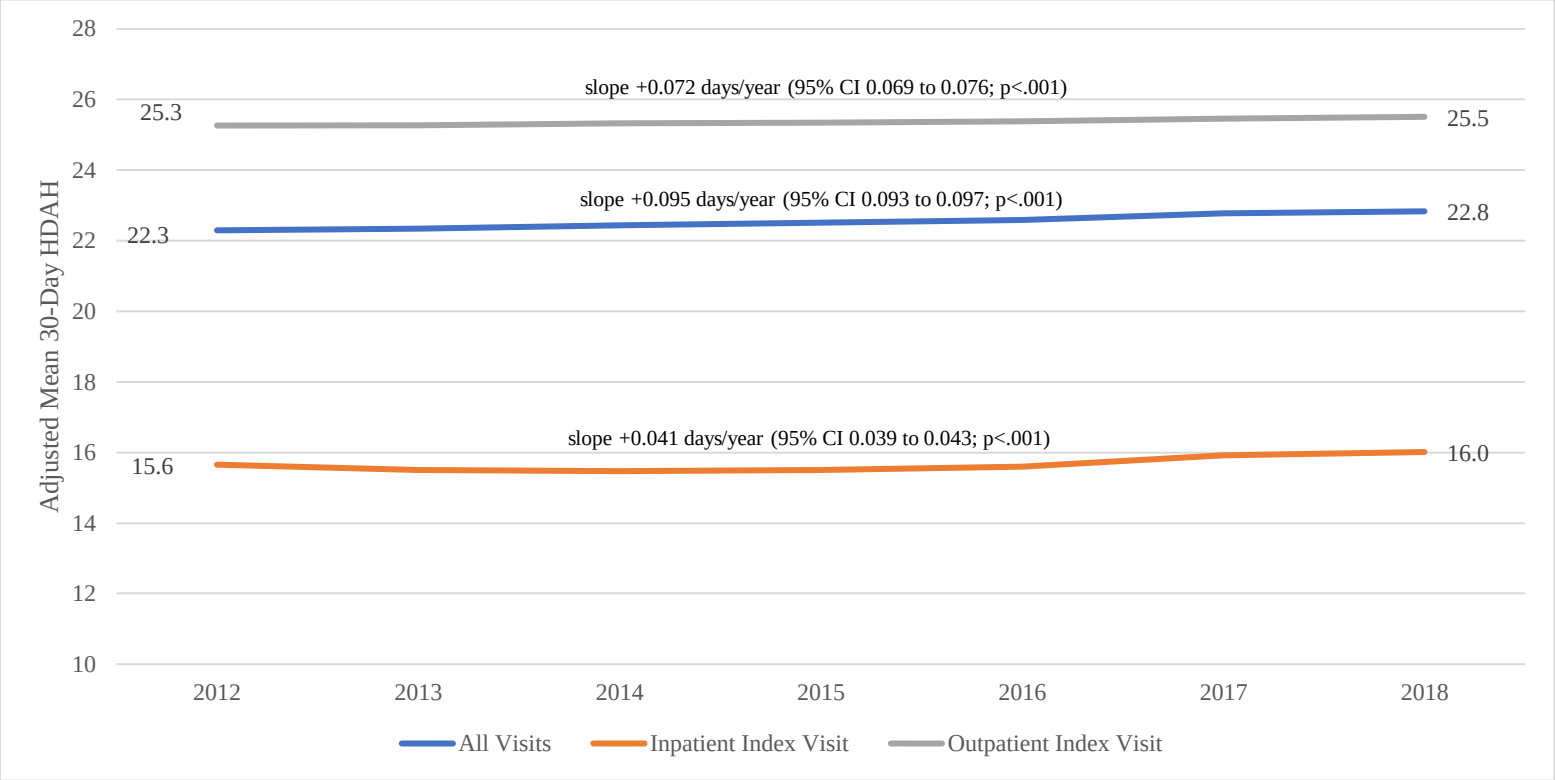
* Each visit was categorized into one of the following mutually exclusive disposition categories: admitted (inpatient claim associated with an ED revenue center code), observation (outpatient ED visit with an associated observation claim), transferred to another hospital (outpatient visit with a disposition recorded as transferred to another hospital), died in the ED. The remaining outpatient ED visits were classified as discharged from the ED.

Supplemental Figure S6. Adjusted trends* over time (2012-2018) in 30-day Healthy Days at Home (HDAH) and its components.



*Slope (days/year) from a linear regression model with 30-day HDAH and each respective component as the outcome and time (year) as the linear predictor, adjusting for hospital random effects as well as beneficiary age, sex, Medicaid eligibility, race and chronic conditions.

Supplemental Figure S7. Trends in adjusted 30-day HDAH* overall and stratified by disposition of the index ED visit



*Linear regression model with 30-day HDAH as the outcome and time (year) as adjusted for patient correlation at hospitals, demographic characteristics and chronic conditions. Slopes were derived using year as the linear predictor and adjusted yearly means using year as a categorical predictor.

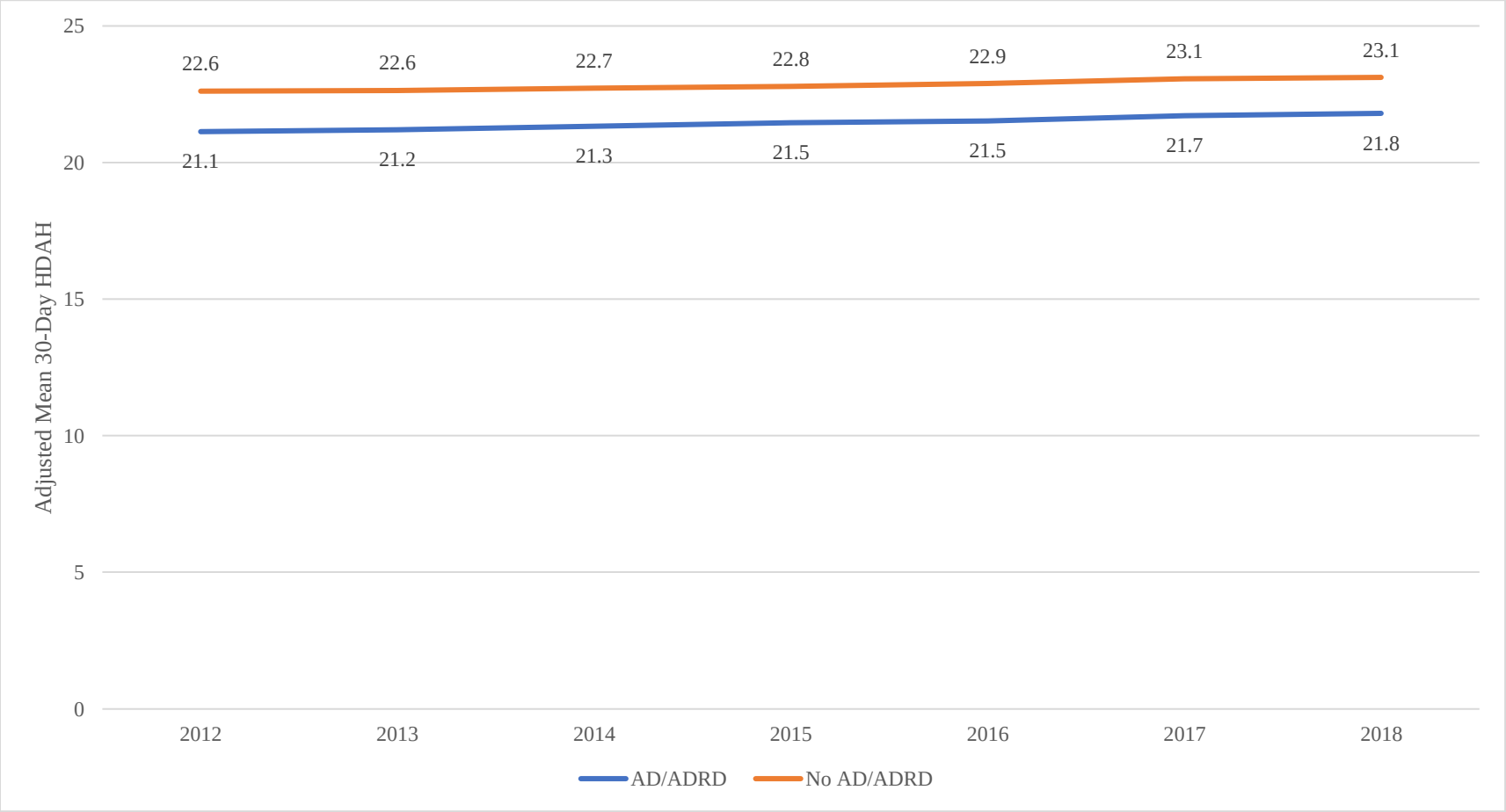
Supplemental Table S8. Trends in 30-Day Healthy Days at Home (HDAH) and its components from 2012-2018 among Medicare beneficiaries ages 65 and older with an emergency department (ED) visit

	Slope in days/year (95% CI)[a]		
Measure	**All Visits**	**Visits among those with AD/ADRD**	**Visits among those without AD/ADRD**
Index Days	-0.04 (-0.041 to -0.039)	-0.036 (-0.038 to -0.035)	-0.041 (-0.042 to -0.040)
Skilled Nursing Facility Days	-0.035 (-0.037 to -0.034)	-0.069 (-0.072 to -0.066)	-0.026 (-0.027 to -0.024)
Mortality Days	-0.024 (-0.025 to -0.023)	-0.031 (-0.033 to -0.029)	-0.022 (-0.023 to -0.021)
Inpatient Days after Index Visit	-0.004 (-0.0051 to -0.0038)	0.002 (0.008 to 0.0035)[b]	-0.0063 (-0.0070 to -0.0056)
Long-term acute care (LTAC) hospital days	-0.0054 (-0.0056 to -0.0051)	-0.0084 (-0.0090 to -0.0078)	-0.0045 (-0.0048 to -0.0042)
Inpatient Psychiatry Days	0.0002 (0.0018 to 0.0023)	0.0040 (0.0035 to 0.0045)	0.0015 (0.0012 to 0.0018)
Inpatient rehabilitation Days	0.0039 (0.0034 to 0.0043)	0.0079 (0.0069 to 0.0088)	0.0028 (0.0023 to 0.0032)
Observation Days	0.0023 (0.0022 to 0.0025)	0.0043 (0.0041 to 0.0046)	0.0018 (0.0016 to 0.0019)
Emergency Department Visit Days	0.0033 (0.0032 to 0.0034)	0.0082 (0.0079 to 0.0085)	0.0023 (0.0021 to 0.0024)
30 Day HDAH	0.095 (0.093 to 0.097)	0.114 (0.110 to 0.119)	0.090 (0.087 to 0.092)

[a]Linear regression model with 30-day HDAH and the respective component parts [skilled nursing facility (SNF) days, duration of the index visit, inpatient days after the index stay, mortality days, ED visit days and observation days after the index visit] as the outcome and time (year) as the linear predictor adjusted for patient correlation at hospitals, demographic characteristics and chronic conditions.

[b]All slope estimates were significant at $p<.001$ with the exception of inpatient days after the index visit among those with AD/ADRD ($p=0.002$).

Supplemental Figure S9. Adjusted trends* over time (2012-2018) in 30-day Healthy Days at Home after an Emergency Department Visit for beneficiaries with and without Alzheimer's Disease and Alzheimer's Disease Related Dementias (AD/ADRD)



*Slope (days/year) from a linear regression model with 30-day HDAH as the outcome and year, AD/ADRD status as well as an interaction between year and AD/ADRD status as the primary predictors. The model also adjusts for hospital random effects as well as beneficiary age, sex, Medicaid eligibility, race and chronic conditions.