Supplemental Online Content

This supplemental material has been provided by the authors to give readers additional information about their work.

eFigure 1. Cohort Enrollment Criteria

```
┌──────────────────────────────────────────┐
│ 325,438 Medicare Beneficiaries >65 years  │
│ with first ICD-9/10 diagnosis PHPT         │
│ 2006 – 2016                                │
└──────────────────────────────────────────┘
          │
          │      ┌──────────────────────────────────────────────┐
          │      │ 73,845 Excluded*                              │
          ├─────▶│ -- Stage 4/5 CKD, on hemodialysis, or prior   │
          │      │ kidney transplant (63,782)                     │
          │      │ -- Prior parathyroidectomy (4,047)            │
          │      │ -- Unknown demographic informationᵃ (7641)     │
          │      │ -- Patients with primary residence outside of  │
          │      │ U.S. (1,532)                                   │
          │      └──────────────────────────────────────────────┘
          ▼
┌──────────────────────────────────────────┐
│ 251,593 Beneficiaries with incident        │
│ diagnosis PHPT                             │
└──────────────────────────────────────────┘
          │
          │      ┌──────────────────────────────────────────────┐
          │      │ 41,387 Excluded                               │
          ├─────▶│ -- lacked continuous enrollment in Medicare   │
          │      │ Part A and B for 12 months before or after     │
          │      │ PHPT diagnosis (19,793)                        │
          │      │ -- gained Part C (Medicare Advantage)          │
          │      │ coverage within 12 months before or after      │
          │      │ PHPT diagnosis (21,594)                        │
          │      └──────────────────────────────────────────────┘
          ▼
┌──────────────────────────────────────────┐
│ 210,206 Continuous enrollment 12 months    │
│ before and 12 months after first diagnosis │
│ of PHPT                                    │
│                                            │
│ 63,136 Parathyroidectomy within            │
│ 1 year of diagnosis                        │
│ 147,070 No parathyroidectomy within        │
│ 1 year of diagnosis                        │
└──────────────────────────────────────────┘
```

* The sum of subcategory totals exceeds the number of total exclusions because some patients met multiple exclusion criteria.

ᵃ Patients were excluded if unknown age, sex, race/ethnicity, area deprivation index, or urban/rural inhabitance.
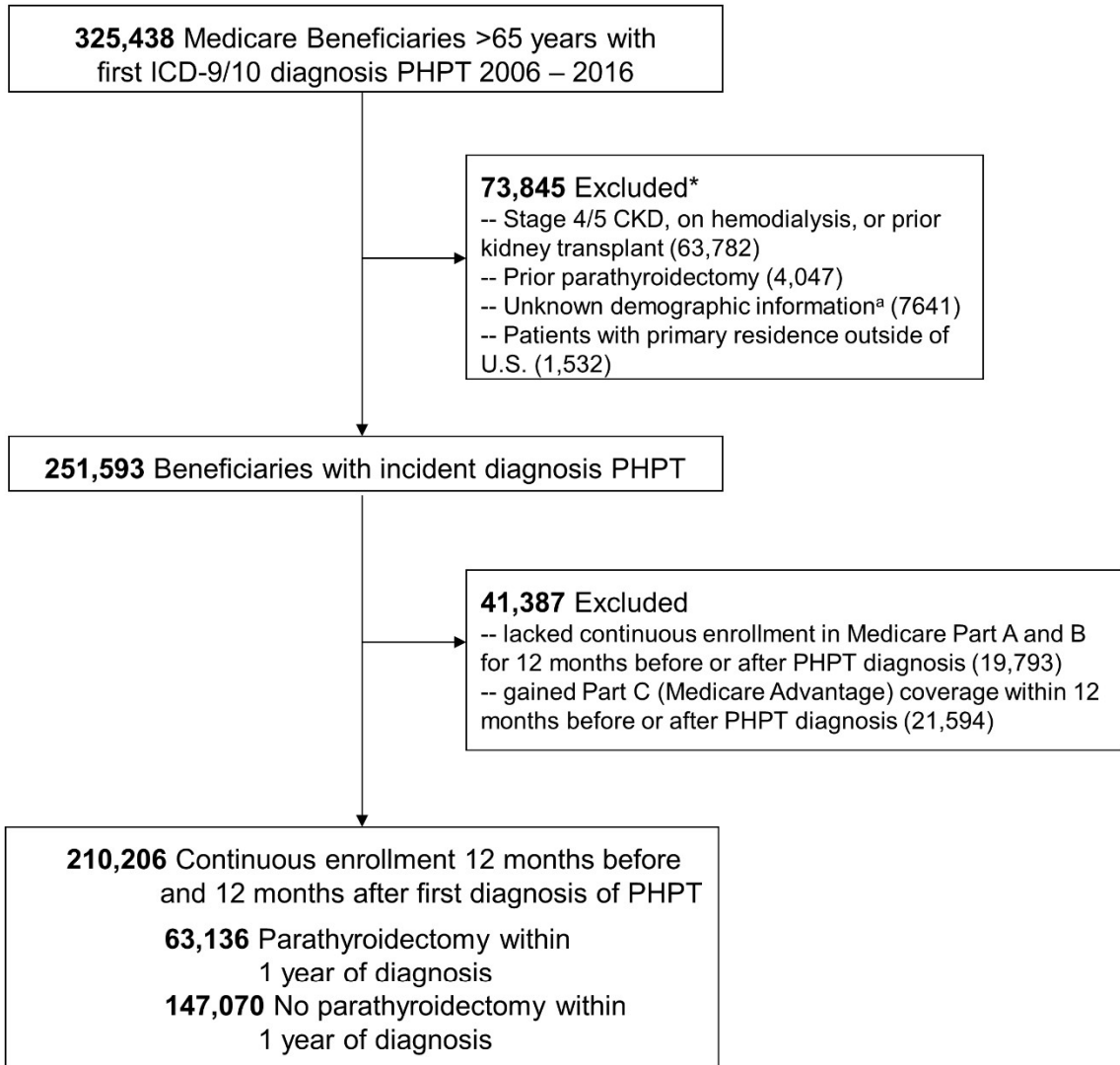
eTable 1. Adjusted hazard of any fracture and hip fracture based on inverse-probability weighted Fine-Gray competing risk regression accounting for the competing risk of death among Medicare beneficiaries with PHPT.

Characteristic	Any Fracture			Hip Fracture		
	Fine-Gray Competing Risk Regression			Fine-Gray Competing Risk Regression		
	IPW Adjusted HR	95% CI		IPW Adjusted HR	95% CI	
Treatment						
Non-operative management	Ref	--	--	Ref	--	--
Parathyroidectomy	0.84	0.82	0.85	0.83	0.80	0.85
Sex						
Male	Ref	--	--	Ref	--	--
Female	1.49	1.45	1.54	1.37	1.30	1.44
Age group						
66 to 75	Ref	--	--	Ref	--	--
76 to 85	1.55	1.52	1.58	2.16	2.08	2.24
86 and above	1.85	1.80	1.91	3.01	2.86	3.16
Race						
White	Ref	--	--	Ref	--	--
Black	0.44	0.42	0.46	0.42	0.39	0.46
Asian	0.73	0.66	0.81	0.77	0.64	0.92
Hispanic	0.93	0.86	1.01	0.83	0.71	0.97
American Native	0.98	0.82	1.18	0.78	0.54	1.12
Unknown	0.63	0.56	0.70	0.54	0.44	0.68
ADI Group						
Most advantaged	Ref	--	--	Ref	--	--

Slightly advantaged	1.01	0.99	1.04	1.07	1.02	1.11
Slightly disadvantaged	1.01	0.98	1.04	1.10	1.05	1.15
Most disadvantaged	1.04	1.01	1.08	1.22	1.15	1.30
Geography						
Urban	Ref	--	--	Ref	--	--
Rural	1.02	1.00	1.53	1.05	0.99	1.08
Frailty						
Robust	Ref	--	--	Ref	--	--
Prefrail	1.34	1.31	1.37	1.22	1.17	1.27
Mildly frail	1.65	1.60	1.71	1.53	1.44	1.62
Moderately-to-severely frail	1.42	1.36	1.49	1.39	1.29	1.50
Charlson Comorbidity Index Score						
0	Ref	--	--	Ref	--	--
1	1.08	1.05	1.11	1.05	1.00	1.10
≥2	1.09	1.07	1.12	1.04	0.99	1.09
Operative indications for parathyroidectomy						
History of osteoporosis	1.67	1.64	1.71	1.41	1.36	1.46
History of kidney stones	0.96	0.93	0.98	0.92	0.88	0.97
History of stage 3 CKD	0.88	0.85	0.91	1.01	0.96	1.07
Endocrinologist care within 6 months of diagnosis	0.98	0.96	1.00	0.93	0.90	0.96
Fracture Risk Factors						
Prior fracture	2.20	2.15	2.25	1.47	1.41	1.54
Tobacco use	1.27	1.22	1.33	1.59	1.48	1.70
Alcohol use disorder	1.44	1.32	1.57	1.44	1.23	1.69
Obesity	0.93	0.90	0.96	0.75	0.70	0.80

* The propensity score used for inverse probability weighting (IPW) in this table was based on all characteristics listed in this table.
Abbreviations: IPW, inverse probability weighted; ADI, area deprivation index; CKD, chronic kidney disease.

eTable 2. Baseline characteristics of subgroup of older adults diagnosed with PHPT from 2006 – 2017 who have continuous enrollment in Medicare Part D (prescription) coverage for 12 months prior to diagnosis.

	Unadjusted							IPW-adjusted[a]			
	Overall cohort (n=210,206)		Parathyroidectomy (n=63,136)		Non-operatively managed (n=147,070)			Overall cohort (n=210,206)	Parathyroidectomy (n=63,136)	Non-operatively managed (n=147,070)	
Characteristic	No.	%	No.	%	No.	%	SMD	%	%	%	SMD
Sex											
Female	89,489	80.9%	25,917	80.6%	63,572	81.1%	0.013	81.1%	81.4%	81.0%	-0.008
Male	21,063	19.1%	6,246	19.4%	14,817	18.9%	-0.013	18.9%	18.6%	19.0%	0.008
Age group											
66 to 75	62,744	56.8%	21,740	67.6%	41,004	52.3%	-0.316	56.6%	56.5%	56.7%	0.004
76 to 85	37,788	34.2%	9,396	29.2%	28,392	36.2%	0.150	34.4%	34.6%	34.2%	-0.008
86 and above	10,020	9.1%	1,027	3.2%	8,993	11.5%	0.322	9.0%	8.9%	9.1%	0.006
Race											
White	95,761	86.6%	28,998	90.2%	66,763	85.2%	-0.152	86.6%	86.5%	86.6%	0.003
Black	10,012	9.1%	2,225	6.9%	7,787	9.9%	0.109	9.1%	9.2%	9.1%	-0.005
Asian	1,388	1.3%	249	0.8%	1,139	1.5%	0.065	1.3%	1.3%	1.3%	-0.003
Hispanic	1,783	1.6%	349	1.1%	1,434	1.8%	0.062	1.6%	1.6%	1.6%	0.001
American Native	220	0.2%	74	0.2%	146	0.2%	-0.010	0.2%	0.2%	0.2%	-0.001
Unknown	1,388	1.3%	268	0.8%	1,120	1.4%	0.056	1.2%	1.2%	1.3%	0.005
ADI Group											
Most advantaged	28,396	25.7%	6,708	20.9%	21,688	27.7%	0.159	25.6%	25.5%	25.7%	0.003
Slightly advantaged	35,104	31.8%	10,202	31.7%	24,902	31.8%	0.001	31.6%	31.5%	31.7%	0.005
Slightly disadvantaged	34,361	31.1%	11,215	34.9%	23,146	29.5%	-0.115	31.2%	31.4%	31.1%	-0.005
Most disadvantaged	12,691	11.5%	4,038	12.6%	8,653	11.0%	-0.047	11.5%	11.6%	11.5%	-0.004

Geography											
Urban	93,187	84.3%	26,029	80.9%	67,158	85.7%	0.127	84.2%	84.1%	84.3%	0.004
Rural	17,365	15.7%	6,134	19.1%	11,231	14.3%	-0.127	15.8%	15.9%	15.7%	-0.004
Frailty											
Robust	35,777	32.4%	11,859	36.9%	23,918	30.5%	-0.135	32.4%	32.6%	32.4%	-0.004
Prefrail	57,976	52.4%	17,039	53.0%	40,937	52.2%	-0.015	52.5%	52.6%	52.4%	-0.003
Mildly frail	11,483	10.4%	2,248	7.0%	9,235	11.8%	0.165	10.3%	10.2%	10.4%	0.007
Moderately-to-severely frail	5,316	4.8%	1,017	3.2%	4,299	5.5%	0.114	4.8%	4.7%	4.8%	0.004
Charlson Comorbidity Index Score											
0	23,753	21.5%	7,991	24.8%	15,762	20.1%	-0.114	21.6%	21.6%	21.5%	-0.002
1	23,664	21.4%	7,230	22.5%	16,434	21.0%	-0.037	21.5%	21.6%	21.4%	-0.004
≥2	63,135	57.1%	16,942	52.7%	46,193	58.9%	0.126	57.0%	56.8%	57.0%	0.005
Operative indications for parathyroidectomy											
History of osteoporosis											
No history	55,699	50.4%	16,772	52.1%	38,927	49.7%	-0.050	50.5%	50.4%	50.5%	-0.002
History based on claim diagnosis	27,180	24.6%	7,696	23.9%	19,484	24.9%	0.022	24.6%	24.2%	24.7%	-0.014
On pharmacologic treatment for osteoporosis	27,673	25.0%	7,695	23.9%	19,978	25.5%	0.036	25.0%	25.4%	24.8%	0.015
History of kidney stones	17,251	15.6%	5,985	18.6%	11,266	14.4%	-0.114	15.5%	15.3%	15.5%	0.006
History of stage 3 CKD	11,568	10.5%	2,420	7.5%	9,148	11.7%	0.141	10.4%	10.3%	10.5%	0.005
Endocrinologist care within 6	51,523	46.6%	18,367	57.1%	33,156	42.3%	-0.299	46.7%	47.0%	46.6%	-0.007

months of diagnosis										
Fracture Risk Factors										
Prior fracture	10,996	9.9%	2,535	7.9%	8,461	10.8%	0.100	10.0%	10.0%	10.0%	-0.002
Tobacco use	5,305	4.8%	1,777	5.5%	3,528	4.5%	-0.047	4.8%	4.8%	4.8%	0.002
Alcohol abuse disorder	933	0.8%	223	0.7%	710	0.9%	0.024	0.9%	0.9%	0.8%	-0.002
Obesity	14,396	13.0%	4,343	13.5%	10,053	12.8%	-0.020	13.0%	12.9%	13.0%	0.004
Pharmacologic Treatment										
Chronic steroid use	1,408	1.3%	306	1.0%	1,102	1.4%	0.021	1.3%	1.3%	1.3%	0.000
Cinacalcet	2,757	2.5%	730	2.3%	2,027	2.6%	0.042	2.6%	2.6%	2.5%	-0.008

a The propensity score used for inverse probability weighting in this table was based on all characteristics listed in this table.

Abbreviations: IPW, inverse probability weighted; ADI, area deprivation index; CKD, chronic kidney disease.

eTable 3. Unadjusted incidence rate and adjusted hazard of any fracture and hip fracture based on inverse-probability weighted Cox proportional hazard regression among subgroup of Medicare beneficiaries with PHPT who have continuous enrollment in Medicare Part D (prescription) coverage for 12 months prior to diagnosis.

| Characteristic | Any Fracture | | | Hip Fracture | | |
| | Unadjusted incidence rate of any fracture | Cox Proportional Hazards Regression | | Unadjusted incidence rate of hip fracture | Cox Proportional Hazards Regression | |
	Rate (per 100 person-years)	IPW Adjusted HR	95% CI	Rate (per 100 person-years)	IPW Adjusted HR	95% CI
Treatment						
Non-operative management	3.18	Ref	--	--	0.89	Ref	--	--
Parathyroidectomy	2.05	0.77	0.74	0.80	0.51	0.73	0.69	0.78
Sex						
Male	1.57	Ref	--	--	0.47	Ref	--	--
Female	3.12	1.44	1.35	1.53	0.84	1.43	1.28	1.61
Age group						
66 to 75	1.80	Ref	--	--	0.38	Ref	--	--
76 to 85	3.87	1.67	1.60	1.74	1.14	2.47	2.28	2.68
86 and above	6.57	2.49	2.36	2.63	2.23	4.33	3.91	4.80
Race						
White	3.01	Ref	--	--	0.82	Ref	--	--
Black	1.25	0.45	0.41	0.50	0.41	0.50	0.42	0.58
Asian	2.20	0.73	0.62	0.87	0.59	0.73	0.53	1.02
Hispanic	2.97	0.91	0.80	1.04	0.79	0.80	0.62	1.03
American Native	3.30	1.38	0.98	1.96	0.53	1.05	0.51	2.14
Unknown	1.80	0.62	0.51	0.77	0.51	0.74	0.51	1.08
ADI Group						
Most advantaged	2.83	Ref	--	--	0.73	Ref	--	--
Slightly advantaged	2.83	1.05	1.00	1.10	0.78	1.20	1.10	1.32
Slightly disadvantaged	2.85	1.05	1.00	1.11	0.79	1.23	1.12	1.35
Most disadvantaged	2.76	1.13	1.06	1.21	0.82	1.43	1.27	1.62
Geography						
Urban	2.83	Ref	--	--	0.77	Ref	--	--
Rural	2.84	1.04	0.99	1.09	0.78	0.97	0.88	1.07

Frailty								
Robust	1.65	Ref	--	--	0.43	Ref	--	--
Prefrail	3.02	1.42	1.36	1.50	0.83	1.44	1.32	1.58
Mildly frail	5.30	2.05	1.92	2.19	1.49	2.27	2.01	2.56
Moderately-to-severely frail	5.38	1.85	1.70	2.01	1.44	1.83	1.57	2.14
Charlson Comorbidity Index Score								
0	2.10	Ref	--	--	0.59	Ref	--	--
1	2.66	1.09	1.03	1.16	0.74	1.06	0.95	1.19
≥2	3.20	1.14	1.08	1.20	0.86	1.05	0.95	1.16
Operative indications for parathyroidectomy								
History of osteoporosis								
No osteoporosis	1.66	Ref	--	--	0.51	Ref	--	--
Diagnosis code only	3.89	1.55	1.48	1.63	1.09	1.38	1.27	1.50
On pharmacologic treatment for osteoporosis	4.11	1.68	1.61	1.76	0.97	1.19	1.09	1.30
History of kidney stones	2.73	0.97	0.92	1.02	0.70	0.92	0.84	1.02
History of stage 3 CKD	3.04	0.95	0.89	1.01	0.92	1.17	1.05	1.30
Endocrinologist care within 6 months of diagnosis	2.77	0.98	0.94	1.01	0.72	0.94	0.87	1.00
Fracture Risk Factors								
Prior fracture	8.82	2.36	2.26	2.46	1.83	1.67	1.53	1.82
Tobacco use	3.63	1.43	1.32	1.55	1.07	1.70	1.47	1.97
Alcohol use disorder	4.95	1.44	1.20	1.72	1.39	1.51	1.08	2.12
Obesity	2.36	0.99	0.93	1.05	0.46	0.74	0.64	0.84
Pharmacologic Treatment								
Chronic steroid use	6.19	1.70	1.51	1.92	1.03	1.25	0.97	1.62
Cinacalcet	3.66	0.90	0.81	1.01	1.21	1.03	0.86	1.25

* The propensity score used for inverse probability weighting in this table was based on all characteristics listed in this table.

Abbreviations: IPW, inverse probability weighted; ADI, area deprivation index; CKD, chronic kidney disease.