Supplementary Online Content

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

eFigure.

$T_{device\ date}$= Device implant date T_{index}= 1 year from device implant date

1 year: Continuous FFS coverage for 12 months before device implant

1 year: Continuous FFS and Part D coverage for 12 months after device implant

1, 2, or 5 years: CIED infection outcome

$T_{device\ date+1\ year}$= 1 year from device implant date

$T_{device\ date}$= Device implant date

$T_{index\ date\ 1}$ = date of device infection

$T_{index\ date\ 2}$= date of device infection + 30 days

1 year: Continuous FFS coverage for 12 months before device implant

Continuous FFS and Part D coverage until device infection

1, 2, or 5 years: device extraction outcome (index date=date of device infection)

1, 2, or 5 years: all-cause mortality outcome (index date₁=date of device infection; index date₂=date of device infection + 30 days)
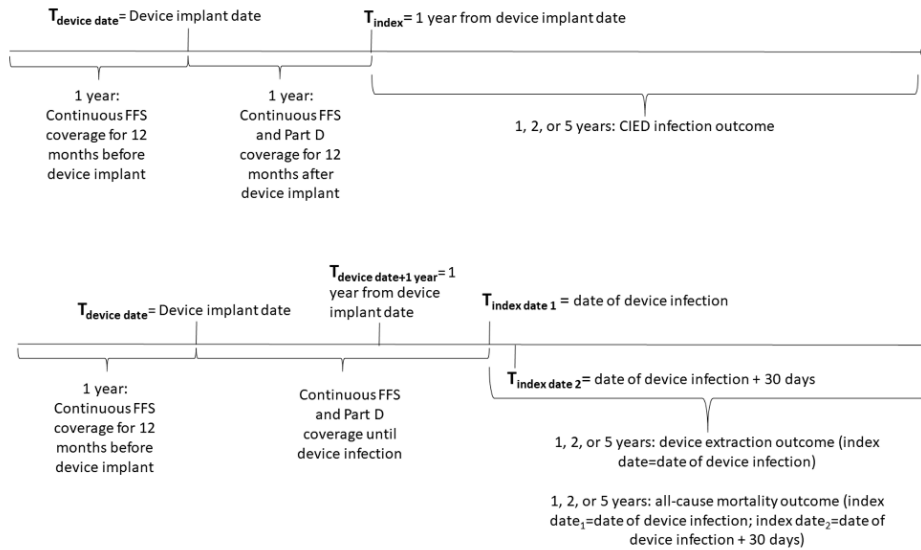
Figure Legend: Graphical demonstration of the study design. $T_{device\ date}$ was the date of de novo pacemaker or implantable cardioverter defibrillator implantation. Inclusion criteria required that patients had 1 year of Medicare fee-for-service coverage prior to device implantation. Panel A demonstrated the rates of cardiac implantable electronic device (CIED) infection. The T_{index} was 1 year after device implant, and the 1-, 2-, and 5-year CIED infection rates were determined from T_{index}. Panel B demonstrated the rates of CIED extraction and the mortality rates for CIED infection patients. The $T_{index\ date\ 1}$ was the date of device infection, and the extraction rates were determined at 1-, 2-, and 5-years after the date of device infection. The $T_{index\ date\ 2}$ was 30 days after the device infection, and all-cause mortality was determined at 1-, 2-, and 5-years after the $T_{index\ date\ 2}$.

eTable 1. Codes used to determine de novo pacemaker or ICD implantation procedure

Pacemaker de novo implant	ICD de novo implant
CPT code	CPT code
33206	33249+33225 [CRT-D]
33207	33249
33208	
33206+33225, 33207+33225, 33208+33225 [CRT-P]	

eTable 2. Codes used to determine CIED infection

ICD-9-CM list*		ICD-10-CM List*	
Code	**Description**	**Code**	**Description**
996.61	Infection and inflammatory reaction due to cardiac device, implant	T82.6XXA	Infection and inflammatory reaction due to cardiac valve prosthesis, initial encounter
996.60	Infection and inflammatory reaction due to unspecified device, implant, and graft	T82.7XXA	Infection and inflammatory reaction due to other cardiac and vascular devices, implants and grafts, initial encounter
996.62	Infection and inflammatory reaction due to vascular device, implant	T85.79XA	Infection and inflammatory reaction due to other internal prosthetic devices, implants and grafts, initial encounter
421.0	Acute and subacute endocarditis	I33.0	Acute and subacute infective endocarditis
421.1	Acute and subacute infective endocarditis in diseases classified elsewhere	I33.9	Acute and subacute endocarditis, unspecified
421.9	Acute endocarditis unspecified	I39	Endocarditis and heart valve disorders in diseases classified elsewhere
424.90	Endocarditis	I38	Endocarditis, valve unspecified
424.91	Endocarditis in diseases classified elsewhere		

* in the primary position from the carrier, inpatient, or outpatient file

eTable 3. Antibiotic therapy

Class	Generic Med name	HCPCS code
Antibiotics	Vancomycin	J3370
	Daptomycin	J0878
	Linezolid	J2020
	Cefazolin	J0690
	Nafcillin	S0032 [Not payable by Medicare]
	Piperacillin-tazobactam	J2543
	Cefepime	J0692
	Meropenem	J2185
	Imipenem	J0743
	Ertapenem	J1335
	Aztreonam	S0073 [Not payable by medicare]
	Ciprofloxacin	J0744
	Micafungin	J2248
	Fluconazole	J1450
	Voriconazole	J3465
	Ceftriaxone	J0696
	Gentamicin	J1580
	Amikacin	J0278
	Tobramycin	J3260
	Ampicillin Sodium/Ampicillin Sulbactam	J0290, J0295
	Clindamycin	S0077 [Not payable by Medicare]
	Metronidazole	S0030 [Not payable by Medicare]
	Trimethoprim/Sulfamethoxazole	S0039 [Not payable by Medicare]

eTable 4. Extraction codes

Code	
CPT 33234	Removal of transvenous pacemaker electrode(s); single lead system, atrial or ventricular
CPT 33235	Removal of transvenous pacemaker electrode(s); dual lead system
CPT 33244	Removal of single or dual chamber pacing cardioverter-defibrillator electrode(s); by transvenous extraction

eTable 5: Baseline characteristics of infection cohort, excluding ESKD and patients < 65 years

N	6,176
Age at infection, years	78.0 (74.0, 84.0)
Age group at infection, %	
<65	0 (0.0)
65-<75	1,854 (30.0)
75-<85	2,908 (47.1)
85+	1,414 (22.9)
Female, %	2,223 (36.0)
Race, %	
White	5,584 (90.4)
Black	334 (5.4)
Other	258 (4.2)
Comorbidities, %	
Dementia	768 (12.4)
Diabetes mellitus	3,535 (57.2)
Ischemic heart disease	5,487 (88.8)
Peripheral vascular disease	3,716 (60.2)
Congestive heart failure	5,061 (81.9)
Cerebrovascular disease	3,106 (50.3)
Hypertension	6,049 (97.9)
Chronic obstructive pulmonary disease	4,104 (66.5)
Renal disease	3,357 (54.4)
Stroke/Transient ischemic attack	1,974 (32.0)
Myocardial infarction	2,517 (40.8)
Cancer	1,801 (29.2)
Valvular heart disease	5,119 (82.9)
Device type, %	
CRT-D	852 (13.8)
CRT-P	156 (2.5)

Pacemaker	3,755 (60.8)
ICD	1,413 (22.9)
Region, %	
Midwest	1,490 (24.1)
Northeast	1,152 (18.7)
South	2,545 (41.2)
West and Other	989 (16.0)
Dual Medicaid eligibility, %	1,250 (20.2)
Time since device implant, years	4.1 (2.6)
Claims-based frailty indicator, %	2,690 (43.6)
Frailty index	0.2 (0.1, 0.4)

eTable 6. Association between extraction and all-cause mortality, excluding ESKD and patients < 65 years

Parameter	HR (95% CI)	p-value
Extraction within 30 days		
Extraction 0-6 days, time-dependent (Ref=No)	0.68 (0.58, 0.79)	< .001
Extraction, 7-30 days, time-dependent (Ref=No)	0.93 (0.74, 1.16)	.51
Age at infection, per 5 years	1.11 (1.07, 1.16)	< .001
Female	1.09 (0.97, 1.23)	.13
Race (Ref=White)		
Black	1.01 (0.82, 1.24)	.93
Other	0.66 (0.50, 0.87)	.004
Medicaid dual eligibility	1.24 (1.08, 1.41)	.002
Region (Ref=South)		
Midwest	0.95 (0.83, 1.09)	.46
Northeast	0.97 (0.84, 1.11)	.66
West	0.82 (0.69, 0.96)	.02
Comorbidities		
Myocardial infarction	1.15 (1.03, 1.29)	.01
Peripheral vascular disease	1.25 (1.12, 1.40)	< .001
Cerebrovascular disease	0.82 (0.70, 0.96)	.01
Dementia	1.82 (1.58, 2.08)	< .001
Chronic obstructive pulmonary disease	1.40 (1.23, 1.59)	< .001
Renal disease	1.55 (1.37, 1.74)	< .001
Congestive heart failure	1.43 (1.19, 1.73)	< .001
Stroke/TIA	1.42 (1.21, 1.66)	< .001
Ischemic heart disease	1.05 (0.85, 1.29)	.66
Diabetes mellitus	1.07 (0.96, 1.20)	.20
Hypertension	0.72 (0.47, 1.11)	.14
Valvular heart disease	1.16 (1.00, 1.36)	.06
Cancer	1.19 (1.07, 1.33)	.002
Device type (Ref=Pacemaker)		

Parameter	HR (95% CI)	p-value
CRT-D	1.28 (1.10, 1.49)	.001
CRT-P	1.08 (0.78, 1.49)	.64
ICD	1.29 (1.13, 1.48)	< .001
Time from device implant, years	1.02 (0.99, 1.04)	.14
Year of infection, per 1 year	1.00 (0.98, 1.02)	.98

The time-dependent indicators of extraction <7 days and extraction 7-30 days were included in the model. Cox model adjusted for age, sex, race, Medicaid dual eligibility, baseline comorbidities, device type, geographic region, year of device infection, and years since device implant.

eTable 7. Association between extraction and all-cause mortality, including adjustment for frailty indicator.

Parameter	HR (95% CI)	p-value
Extraction within 30 days		
Extraction 0-6 days, time-dependent (Ref=No)	0.69 (0.61, 0.78)	< .001
Extraction, 7-30 days, time-dependent (Ref=No)	0.88 (0.74, 1.05)	.15
Age at infection, per 5 years	1.05 (1.03, 1.07)	< .001
Female	1.07 (1.00, 1.15)	.05
Race (Ref=White)		
Black	0.92 (0.83, 1.01)	.08
Other	0.86 (0.75, 0.99)	.03
Medicaid dual eligibility	1.14 (1.05, 1.23)	.002
Region (Ref=South)		
Midwest	0.95 (0.87, 1.04)	.26
Northeast	0.91 (0.83, 1.00)	.04
Other	1.07 (0.42, 2.76)	.89
West	0.85 (0.75, 0.95)	.003
Comorbidities		
Myocardial infarction	1.12 (1.04, 1.21)	.002
Peripheral vascular disease	1.26 (1.17, 1.37)	< .001
Cerebrovascular disease	0.96 (0.87, 1.06)	.41
Dementia	1.43 (1.30, 1.58)	< .001
Chronic obstructive pulmonary disease	1.23 (1.13, 1.34)	< .001
Renal disease	1.90 (1.71, 2.10)	< .001
Congestive heart failure	1.43 (1.24, 1.65)	< .001
Stroke/TIA	1.23 (1.11, 1.36)	< .001
Ischemic heart disease	1.09 (0.92, 1.28)	.32
Diabetes mellitus	1.13 (1.04, 1.23)	.003
Hypertension	0.92 (0.62, 1.35)	.66

Parameter	HR (95% CI)	p-value
Valvular heart disease	1.13 (1.03, 1.24)	.008
Cancer	1.13 (1.05, 1.22)	.001
Device type (Ref=Pacemaker)		
CRT-D	1.07 (0.96, 1.19)	.23
CRT-P	0.97 (0.76, 1.23)	.78
ICD	1.15 (1.05, 1.25)	.002
Time from device implant, years	1.00 (0.99, 1.02)	.87
Year of infection, per 1 year	0.99 (0.98, 1.00)	.09
Frailty indicator	1.29 (1.18, 1.41)	< .001

The time-dependent indicators of extraction <7 days and extraction 7-30 days were included in the model. Cox model adjusted for age, sex, race, Medicaid dual eligibility, baseline comorbidities, device type, geographic region, frailty, year of device infection, and years since device implant.