

SUPPLEMENTAL MATERIAL

- Supplemental Table 1: ICD-9-CM diagnosis codes used to identify long-term ICD complications
Adapted from Ranasinghe et al., Ann Intern Med. 2016: 165:20-29.
- Supplemental Table 2: Claims codes used for defining ICD reoperations for reasons other than complications
Adapted from Ranasinghe et al., Ann Intern Med. 2016: 165:20-29.
- Supplemental Table 3: Additional Baseline Characteristics by Physician Specialties

Supplemental Table 1

Complication				Codes Used to Identify
	Primary Diagnosis*	Secondary Diagnosis*	ICD-9-CM Diagnosis Code	Code Description
Mechanical complication	X		996.04	Mechanical complication of automatic implantable cardiac defibrillator
	X		996.01	Mechanical complication due to cardiac pacemaker (electrode)
	X		996.09	Other mechanical complication of cardiac device, implant, and graft
	X		996.00	Mechanical complication of unspecified cardiac device, implant, and
	X		996.0x	Mechanical complication of cardiac device implant and graft
	X		996.72	Other complications due to other cardiac device, implant, and graft
Infection				
Device specific	X	X	996.61	Infection and inflammatory reaction due to cardiac device, implant, and graft
Systemic infection	X	X	038.xx	Septicemia
	X	X	785.52	Septic shock
	X	X	790.7	Bacteremia
Endocarditis	X	X	421.0	Acute and subacute bacterial endocarditis
	X	X	421.9	Acute endocarditis, unspecified
	X	X	424.9	Endocarditis, valve unspecified
Other infection	X		998.5	Postoperative infection not elsewhere classified
	X		998.51	Infected postoperative seroma
	X		998.59	Other postoperative infection
	X		999.3x	Other infection due to medical care not elsewhere classified
	X		682.2	Cellulitis of the trunk
Pneumothorax	X		512.1	Iatrogenic pneumothorax
Pleural effusion	X		511.9	Unspecified pleural effusion
Pericardial effusion	X		423.0	Hemopericardium
	X		423.3	Cardiac tamponade
	X		423.9	Unspecified disease of pericardium (note no specific code for pericardial effusion, this is what is typically used)
Perforation	X		998.2	Accidental puncture or laceration during a procedure, not elsewhere classified
Superior vena cava obstruction/venous thromboembolism	X	X	459.2	Compression of vein
	X	X	453.72	Chronic venous embolism and thrombosis of deep veins of upper extremity
	X	X	453.74	Chronic venous embolism and thrombosis of axillary veins
	X	X	453.75	Chronic embolism subclavian veins
	X	X	453.77	Chronic venous embolism and thrombosis of other thoracic veins
	X		453.83	Acute venous embolism and thrombosis of deep veins of upper
	X		453.84	Acute venous embolism and thrombosis of axillary veins
	X		453.85	Acute venous embolism and thrombosis of subclavian veins
	X		453.86	Acute venous embolism and thrombosis of internal jugular veins
	X		453.87	Acute venous embolism and thrombosis of other thoracic veins
	X		415.1x	Pulmonary embolism and infarction
Pocket-related complications				
Hemorrhage or hematoma/seroma	X		998.1x	Hemorrhage or hematoma complicating a procedure not elsewhere classified
Wound disruption	X		998.3x	Disruption of operation wound
	X		998.83	Nonhealing surgical wound
Foreign body/reaction to foreign substance left during procedure	X		998.4	Foreign body accidentally left during a procedure
	X		998.7	Acute reaction to foreign substance accidentally left during a procedure
Persistent postoperative fistula	X		998.6	Persistent postoperative fistula

Supplemental Table 2: Claims codes used for defining ICD reoperations for reasons other than complications

Claims Code, by Type of Reoperation	Code Type	Code Description
Pocket reoperation		
33223	CPT	Revision of skin pocket for cardioverter-defibrillator
3779	ICD-9-CM	Revision or relocation of cardiac device pocket
Generator reoperation		
33230	CPT	Insertion of pacing cardioverter-defibrillator pulse generator only; with existing dual leads
33231	CPT	Insertion of pacing cardioverter-defibrillator pulse generator only; with existing multiple leads
33249	CPT	Insertion or replacement of permanent pacing cardioverter-defibrillator system with transvenous lead(s), single or dual chamber
33240	CPT	Insertion of pacing cardioverter-defibrillator pulse generator only; with existing single lead
33262	CPT	Removal of pacing cardioverter-defibrillator pulse generator with replacement of pacing cardioverter-defibrillator pulse generator; single lead system
33263	CPT	Removal of pacing cardioverter-defibrillator pulse generator with replacement of pacing cardioverter-defibrillator pulse generator; dual lead system
33264	CPT	Removal of pacing cardioverter-defibrillator pulse generator with replacement of pacing cardioverter-defibrillator pulse generator; multiple lead system
33241	CPT	Removal of pacing cardioverter-defibrillator pulse generator only
3798	ICD-9-CM	Replacement of automatic cardioverter defibrillator pulse generator only
3794	ICD-9-CM	Implantation or replacement of automatic cardioverter defibrillator, total system [aicd]
3796	ICD-9-CM	Implantation of automatic cardioverter/defibrillator pulse generator only
0051	ICD-9-CM	Implantation of cardiac resynchronization defibrillator, total system [crt-d]
0054	ICD-9-CM	Implantation or replacement of cardiac resynchronization defibrillator pulse generator only [crt-d]
3789	ICD-9-CM	Revision or removal of pacemaker device
Lead reoperation alone		
33216	CPT	Insertion of a single transvenous electrode, permanent pacemaker or cardioverter-defibrillator
33217	CPT	Insertion of 2 transvenous electrodes, permanent pacemaker or cardioverter-defibrillator
33224	CPT	Insertion of pacing electrode, cardiac venous system, for left ventricular pacing, with attachment to previously placed pacemaker or pacing cardioverter-defibrillator pulse generator (including revision of pocket, removal, insertion, and/or replacement of existing generator)
33225	CPT	Insertion of pacing electrode, cardiac venous system, for left ventricular pacing, at time of insertion of pacing cardioverter-defibrillator or pacemaker pulse generator (e.g., for upgrade to dual chamber system) (list separately in addition to code for primary procedure)
33202	CPT	Insertion of epicardial electrode(s); open incision (e.g., thoracotomy, median sternotomy, subxiphoid approach)
33203	CPT	Insertion of epicardial electrode(s); endoscopic approach (e.g., thoracoscopy, pericardioscopy)
33215	CPT	Repositioning of previously implanted transvenous pacemaker or pacing cardioverter-defibrillator (right atrial or right ventricular) electrode
33218	CPT	Repair of single transvenous electrode, permanent pacemaker or pacing cardioverter-defibrillator
33220	CPT	Repair of 2 transvenous electrodes for permanent pacemaker or pacing cardioverter-defibrillator
33226	CPT	Repositioning of previously implanted cardiac venous system (left ventricular) electrode (including removal, insertion and/or replacement of existing generator)
33243	CPT	Removal of single or dual chamber pacing cardioverter-defibrillator electrode(s); by thoracotomy
33244	CPT	Removal of single or dual chamber pacing cardioverter-defibrillator electrode(s); by transvenous extraction
33234	CPT	Removal of transvenous pacemaker electrode(s); single lead system, atrial or ventricular
33235	CPT	Removal of transvenous pacemaker electrode(s); dual lead system
33238	CPT	Removal of permanent transvenous electrode(s) by thoracotomy
0052	ICD-9-CM	Implantation or replacement of transvenous lead [electrode] into left ventricular coronary venous system
3770	ICD-9-CM	Initial insertion of lead [electrode], not otherwise specified
3771	ICD-9-CM	Initial insertion of transvenous lead [electrode] into ventricle
3772	ICD-9-CM	Initial insertion of transvenous leads [electrodes] into atrium and ventricle
3773	ICD-9-CM	Initial insertion of transvenous lead [electrode] into atrium
3774	ICD-9-CM	Insertion or replacement of epicardial lead [electrode] into epicardium
3797	ICD-9-CM	Replacement of automatic cardioverter/defibrillator lead(s) only
3795	ICD-9-CM	Implantation of automatic cardioverter/defibrillator lead(s) only
3775	ICD-9-CM	Revision of lead [electrode]
3777	ICD-9-CM	Removal of lead(s) [electrode] without replacement

CPT = Current Procedural Terminology; ICD = implantable cardioverter-defibrillator; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification. Adapted from Ranasinghe et al., 2016.

Supplemental Table 3:

Description	Total		Physician Specialty										p-value
			Electrophysiologist		Interventional Cardiologist		General Cardiologist		Thoracic Surgeon		Other Specialist		
	#	%	#	%	#	%	#	%	#	%	#	%	
ALL	107966	100.0	74505	100.0	6219	100.0	20795	100.0	1790	100.0	4657	100.0	
Demographics													
Hispanic Ethnicity	4040	3.7	2593	3.5	296	4.8	750	3.6	155	8.7	246	5.3	<.001
Insurance Payor													
Government: Medicare	106344	98.5	73312	98.4	6146	98.8	20514	98.6	1776	99.2	4596	98.7	0.012
Government: Medicaid	325	0.3	233	0.3	18	0.3	60	0.3	5	0.3	9	0.2	
Government: Other	120	0.1	85	0.1	4	0.1	26	0.1	1	0.1	4	0.1	
Commercial	828	0.8	613	0.8	45	0.7	129	0.6	4	0.2	37	0.8	
HMO	166	0.2	123	0.2	4	0.1	33	0.2	3	0.2	3	0.1	
Other	183	0.2	139	0.2	2	0.0	33	0.2	1	0.1	8	0.2	
Hospital Reason													
Admitted for this Procedure	64545	59.8	44084	59.2	4004	64.4	12859	61.8	933	52.1	2665	57.2	<.001
Hospitalized-Cardiac	14607	13.5	10142	13.6	748	12.0	2728	13.1	318	17.8	671	14.4	
Hospitalized-Non-Cardiac	24893	23.1	17518	23.5	1287	20.7	4506	21.7	441	24.6	1141	24.5	
Missing or Unknown	3921	3.6	2761	3.7	180	2.9	702	3.4	98	5.5	180	3.9	
History and Risk Factors													
Sinus Node Function: Abnormal	35351	32.7	24492	32.9	1977	31.8	6615	31.8	666	37.2	1601	34.4	<.001
Non-Ischemic Dilated Cardiomyopathy	28977	26.8	20269	27.2	1459	23.5	5541	26.6	459	25.6	1249	26.8	<.001
Previous Valvular Surgery	9309	8.62	6560	8.80	419	6.74	1787	8.59	170	9.50	373	8.01	<.001
Diagnostics													

%EF: Categories													
Missing	1367	1.3	875	1.2	107	1.7	285	1.4	26	1.5	74	1.6	
<=15	10793	10.0	7412	9.9	619	10.0	2071	10.0	234	13.1	457	9.8	
>15 to 20	19897	18.4	13708	18.4	1165	18.7	3751	18.0	383	21.4	890	19.1	<.001
>20 to 25	22856	21.2	15825	21.2	1275	20.5	4439	21.3	388	21.7	929	19.9	
>25	53053	49.1	36685	49.2	3053	49.1	10249	49.3	759	42.4	2307	49.5	
Electrophysiology Study Done	15957	14.8	12400	16.6	299	4.8	2460	11.8	146	8.2	652	14.0	<.001
PR Interval Attainable	75828	70.2	52268	70.2	4420	71.1	14621	70.3	1207	67.4	3312	71.1	0.028
PR Interval When PR Interval Attainable	185.60	39.3	185.82	39.3	184.78	39.0	185.36	39.2	185.02	39.6	184.48	39.1	0.042
Atrioventricular Conduction													
Normal	70041	64.9	48376	64.9	4124	66.3	13478	64.8	1103	61.6	2960	63.6	
Abnormal-1st Degree Heart Block Only	20890	19.3	14540	19.5	1149	18.5	3936	18.9	312	17.4	953	20.5	<.001
Abnormal-Heart Block 2nd or 3rd Degree	5070	4.7	3475	4.7	264	4.2	981	4.7	114	6.4	236	5.1	
Paced (any)	11965	11.1	8114	10.9	682	11.0	2400	11.5	261	14.6	508	10.9	
Intraventricular Conduction													
Normal	39150	36.3	26802	36.0	2438	39.2	7586	36.5	669	37.4	1655	35.5	
Abnormal-LBBB	32339	30.0	22851	30.7	1682	27.0	5968	28.7	446	24.9	1392	29.9	
Abnormal-RBBB, Bifascicular Block (RBBB Plus LAF, RBBB Plus LPF)	11495	10.6	7979	10.7	640	10.3	2137	10.3	206	11.5	533	11.4	<.001
Paced	10916	10.1	7364	9.9	630	10.1	2241	10.8	242	13.5	439	9.4	
Other	14066	13.0	9509	12.8	829	13.3	2863	13.8	227	12.7	638	13.7	
BUN Level: Mean (SD)	26.23	14.3	26.33	14.3	25.83	14.1	25.87	13.9	27.34	15.8	26.28	14.7	<.001
Systolic BP: Mean (SD)	132.88	22.6	132.49	22.5	133.38	22.7	133.92	22.8	132.53	22.5	133.85	23.0	<.001

Abbreviations: HMO, health maintenance organization; EF, ejection fraction; LBBB, left bundle branch block; RBBB, right bundle branch block; LAF, left anterior fascicular; LPF, left posterior fascicular; SD, standard deviation; BUN, blood urea nitrogen; BNP, blood natriuretic peptide; BP, blood pressure

