



Supporting Information

Supplementary methods and results

**This appendix was part of the submitted manuscript and has been peer reviewed.
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Appendix to: Shawon MSR, Sotade OT, Li J, et al. Factors associated with cardiac implantable electronic device-related infections, New South Wales, 2016–21: a retrospective cohort study. *Med J Aust* 2024; doi: 10.5694/mja2.52302.

Table 1. Australian Classification of Health Interventions (ACHI) procedure codes used to identify people who undergone cardiac implantable electronic device (CIED) procedures

Category	Code	Definition
Permanent pacemaker generator insertion, replacement or revision	38353-00	Insertion of cardiac pacemaker generator
	38353-01	Replacement of cardiac pacemaker generator
	90203-05	Adjustment of cardiac pacemaker generator
Permanent pacemaker lead insertion, replacement or revision	38350-00	Insertion of permanent transvenous electrode into other heart chamber(s) for cardiac pacemaker
	38470-00	Insertion of permanent epicardial electrode for cardiac pacemaker via thoracotomy or sternotomy
	38473-00	Insertion of permanent epicardial electrode for cardiac pacemaker via subxyphoid approach
	38350-01	Replacement of permanent transvenous electrode of other heart chamber(s) for cardiac pacemaker
	38456-23	Replacement of permanent epicardial electrode for cardiac pacemaker via subxiphoid approach
	38456-24	Replacement of permanent epicardial electrode for cardiac pacemaker via thoracotomy or sternotomy
	38456-21	Adjustment of epicardial electrode for cardiac pacemaker
	90203-00	Adjustment of transvenous electrode for cardiac pacemaker
Implantable cardioverter-defibrillator generator insertion, replacement or revision	38393-00	Insertion of cardiac defibrillator generator
	38393-01	Replacement of cardiac defibrillator generator
	90203-06	Adjustment of cardiac defibrillator generator
Implantable cardioverter-defibrillator lead insertion, replacement or revision	38390-02	Insertion of permanent transvenous electrode into other heart chamber(s) for cardiac defibrillator
	38470-01	Insertion of permanent epicardial electrode for cardiac defibrillator via thoracotomy or sternotomy
	38473-01	Insertion of permanent epicardial electrode for cardiac defibrillator via subxyphoid approach
	38350-03	Replacement of transvenous electrode of other heart chamber(s) for cardiac defibrillator
	38456-30	Replacement of permanent epicardial electrode for cardiac defibrillator via subxiphoid approach
	38456-31	Replacement of permanent epicardial electrode for cardiac defibrillator via thoracotomy or sternotomy
	38456-28	Adjustment of epicardial electrode for cardiac defibrillator
	90203-08	Adjustment of transvenous electrode for cardiac defibrillator
Cardiac resynchronisation therapy pacemaker lead insertion, replacement or revision	38368-00	Insertion of permanent transvenous electrode into left ventricle for cardiac pacemaker
	38654-00	Insertion of permanent left ventricular electrode for cardiac pacemaker via thoracotomy or sternotomy
	38368-01	Replacement of permanent transvenous electrode of left ventricle for cardiac pacemaker
	38654-01	Replacement of permanent left ventricular electrode for cardiac pacemaker via thoracotomy or sternotomy

Category	Code	Definition
	90203-02	Adjustment of left ventricular electrode for cardiac pacemaker via thoracotomy, sternotomy or subxyphoid approach
Cardiac resynchronisation therapy defibrillator lead insertion, replacement or revision	38390-01	Insertion of permanent transvenous electrode into left ventricle for cardiac defibrillator
	38654-03	Insertion of permanent left ventricular electrode for cardiac defibrillator via thoracotomy or sternotomy
	38368-03	Replacement of transvenous electrode of left ventricle for cardiac defibrillator
	38654-04	Replacement of permanent left ventricular electrode for cardiac defibrillator via thoracotomy of sternotomy
	90203-09	Adjustment of left ventricular electrode for cardiac defibrillator via thoracotomy, sternotomy or subxyphoid approach

Table 2. The ICD-10-AM diagnosis codes and ACHI procedure codes to be used to identify cardiac implantable electronic device (CIED)-related infections and repeat operations

Category	Code	Definition	ICD-10-AM/ACHI Edition
Diagnoses Codes			
Device specific infection	T82.7	Infection and inflammatory reaction due to other cardiac and vascular devices, implants and grafts	Ninth
	T82.71	Infection and inflammatory reaction due to electronic cardiac device	Tenth
Presence of cardiac device	Z95.0	Presence of cardiac device	Tenth
	Z45.0	Adjustment and management of cardiac device	Tenth
Endocarditis	I33.0	Acute and subacute infective endocarditis	Tenth
	I33.9	Acute endocarditis, unspecified	Tenth
Procedure Codes			
Generator removal	38353-02	Removal of cardiac pacemaker generator	Tenth
	90203-07	Removal of cardiac defibrillator	Tenth
Lead removal	38350-02	Removal of permanent transvenous electrode of other heart chamber(s) for cardiac pacemaker	Tenth
	38350-04	Removal of permanent transvenous electrode of other heart chamber(s) for cardiac defibrillator	Tenth
	38358-00	Removal of permanent transvenous electrode of other heart chamber(s) for cardiac pacemaker using extraction device	Tenth
	38358-01	Removal of permanent transvenous electrode of left ventricle for cardiac pacemaker using extraction device	Tenth
	38358-02	Removal of permanent transvenous electrode of left ventricle for cardiac defibrillator using extraction device	Tenth
	38358-03	Removal of permanent transvenous electrode of other heart chamber(s) for cardiac defibrillator using extraction device	Tenth
	38368-02	Removal of permanent transvenous electrode of left ventricle for cardiac pacemaker	Tenth
	38368-04	Removal of permanent transvenous electrode of left ventricle for cardiac defibrillators	Tenth
	38456-26	Removal of permanent epicardial electrode for cardiac pacemaker via subxiphoid approach	Tenth
	38456-27	Removal of permanent epicardial electrode for cardiac pacemaker via thoracotomy or sternotomy	Tenth
	38456-33	Removal of permanent epicardial electrode for cardiac defibrillator via subxyphoid approach	Tenth
38456-34	Removal of permanent epicardial electrode for cardiac defibrillator via thoracotomy or sternotomy	Tenth	
38654-02	Removal of permanent left ventricular electrode for cardiac pacemaker via thoracotomy or sternotomy	Tenth	
38654-05	Removal of permanent left ventricular electrode for cardiac defibrillator via thoracotomy or sternotomy	Tenth	

Table 3. ICD-10 AM used to identify medical conditions in hospitalisation records

Condition	ICD-10 AM codes
Diabetes	E10, E11, E12, E13, E14
Hypertension	I10, U82.3, I11, I12, I13, I15
Chronic obstructive pulmonary disease	J43, J44, U83.2
Congestive heart failure	I43, I50, I09.9, I11.0, I13.0, I13.2, I42.0, I42.5, I42.6, I42.7, I42.8, I42.9, P29.0, U82.2
Chronic kidney disease	N18, U87.1
Cardiomyopathy	I42
Coronary artery disease	I20, I21, I22, I24, I25, U82.1
Sleep apnoea	G47.3
Obesity	E66, U78.1
Stroke	G45, G46, H34.0, I60, I61, I62, I63, I64, I65, I66, I67, I68, I69
Peripheral vascular disease	I70, I71, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9, U82.2
Atrial fibrillation	I48

Figure 1. Selection of cardiac implantable electronic device (CIED) procedures for inclusion in our analysis

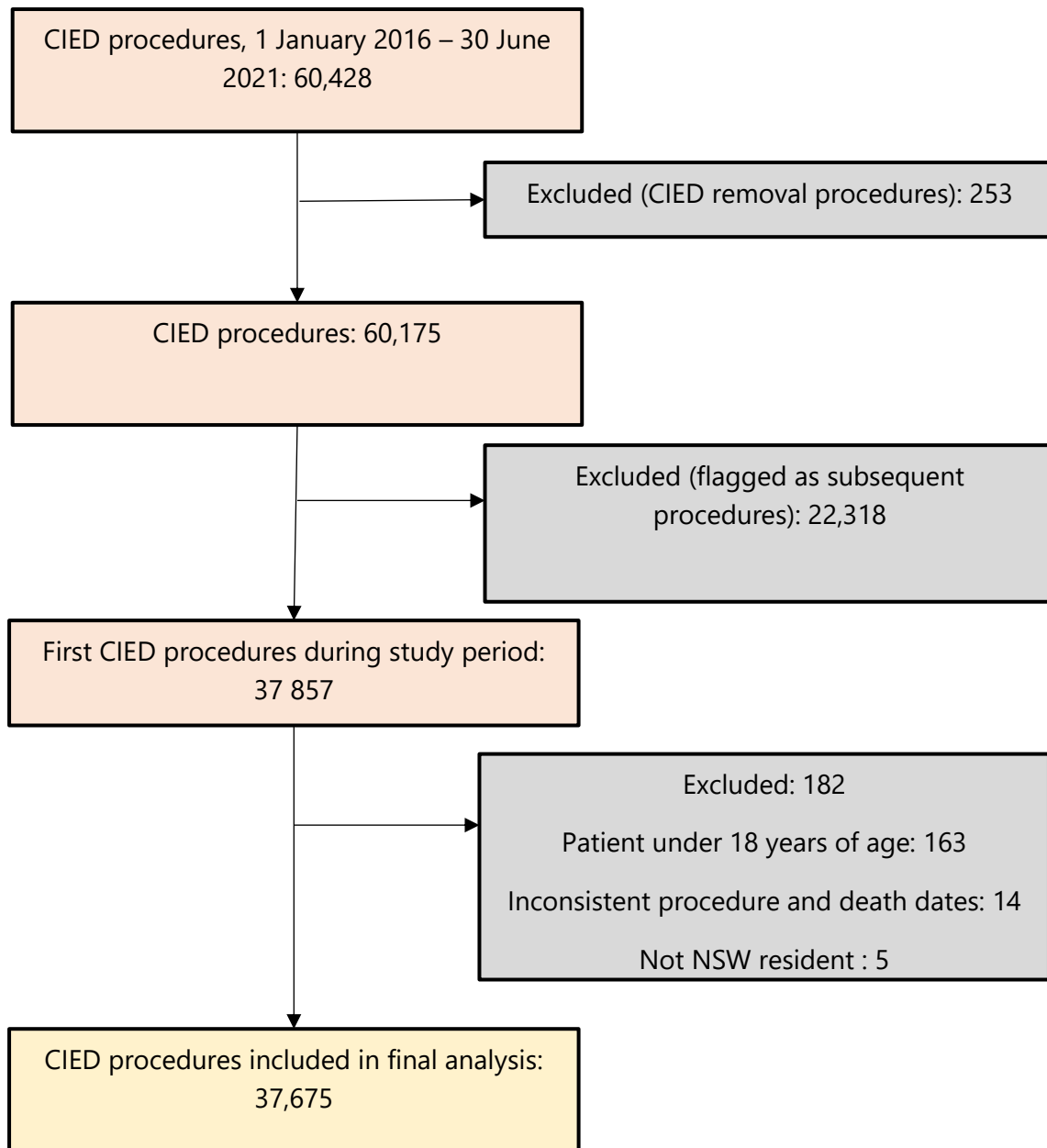
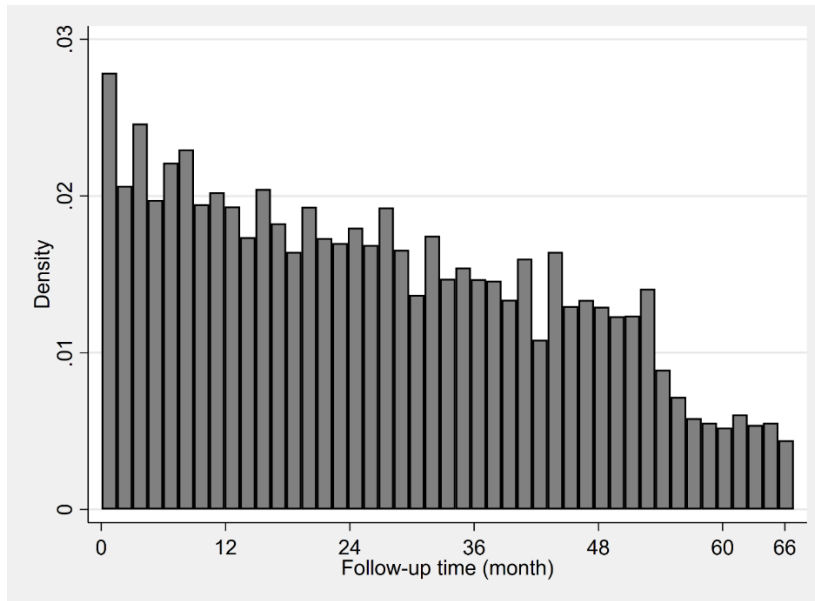


Figure 2. Distribution of follow-up time after cardiac implantable electronic device (CIED) procedures



* Density approximates a probability density function.

Table 4. Characteristics of people who underwent cardiac implantable electronic device (CIED) procedures in New South Wales, 2016–21 (public hospitals) or 2016–20 (private hospitals), by CIED infection status: patients at high risk of CIED-related infections

Characteristics	CIED infection		P
	No	Yes	
Number of patients	10354 (98.2%)	186 (1.8%)	
Age (years), mean (standard deviation)	75.4 (13.7)	71.9 (14.8)	<0.001
Sex (female)	3532 (34.1%)	64 (34.4%)	0.93
Device type			<0.001
Permanent pacemaker	6164 (59.5%)	86 (46.2%)	
Implantable cardioverter defibrillator	2615 (25.3%)	49 (26.3%)	
Cardiac resynchronisation therapy pacemaker	217 (2.1%)	7 (3.8%)	
Cardiac resynchronisation therapy defibrillator	1358 (13.1%)	44 (23.7%)	
Procedure type			0.06
New	1071 (10.3%)	29 (15.6%)	
Revision	21 (0.2%)	0	
Replacement (including upgrades)	9262 (89.5%)	157 (84.4%)	
Prior CIED procedures*			0.003
None	4000 (38.6%)	67 (36.0%)	
One	5549 (53.6%)	92 (49.5%)	
Two or more	805 (7.8%)	27 (14.5%)	
Previous CIED-related infections*	208 (2.0%)	44 (23.7%)	<0.001
Emergency admission	957 (9.2%)	36 (19.4%)	<0.001
Private insurance	6194 (59.8%)	103 (55.4%)	0.22
Length of stay (days), median (interquartile range)	1 (1,1)	1 (1,8)	<0.001
Medical history†			
Diabetes	2915 (28.2%)	59 (31.7%)	0.28
Hypertension	7182 (69.4%)	141 (75.8%)	0.06
Coronary artery disease	5121 (49.5%)	117 (62.9%)	<0.001
Congestive heart failure	4274 (41.3%)	123 (66.1%)	<0.001
Atrial fibrillation	2481 (24.0%)	73 (39.2%)	<0.001
Cardiomyopathy	1217 (11.8%)	49 (26.3%)	<0.001
Peripheral vascular disease	2772 (26.8%)	76 (40.9%)	<0.001
Stroke	782 (7.6%)	19 (10.2%)	0.17
Chronic obstructive pulmonary disease	1632 (15.8%)	43 (23.1%)	0.007
Sleep apnoea	296 (2.9%)	12 (6.5%)	0.004
Chronic kidney disease	2358 (22.8%)	69 (37.1%)	<0.001
Obesity	1458 (14.1%)	48 (25.8%)	<0.001
Hospital type			0.06
Public	5338 (51.6%)	109 (58.6%)	
Private	5016 (48.4%)	77 (41.4%)	

* Calculated by looking into hospitalisations since 1 July 2001

† Calculated by looking into hospitalisations in preceding 12 months

P values are from chi-square test for categorical variables and 2-sample t-test or Mann Whitney test for continuous variables

Figure 3. Cumulative incidence of first cardiac implantable electronic device (CIED)-related infections for patients at high risk of such infections: Kaplan–Meier curve (with 95% confidence interval)

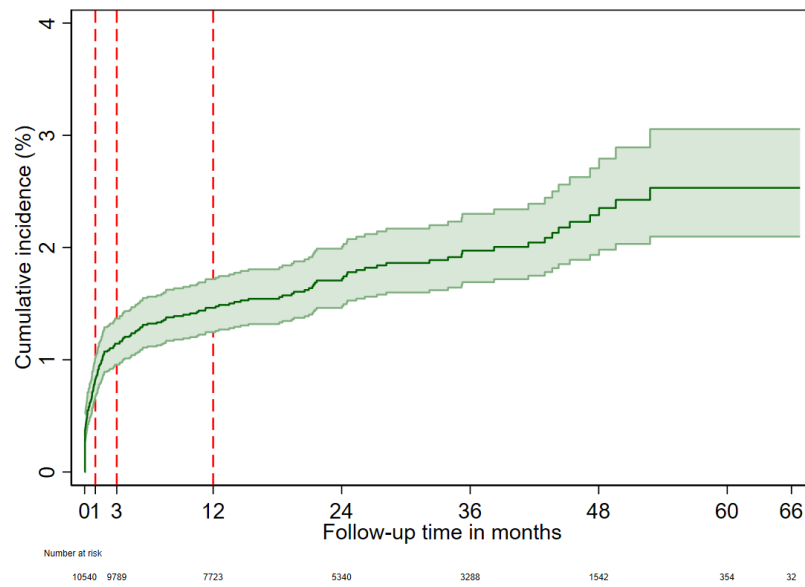


Table 5. Factors associated with cardiac implantable electronic device (CIED) infection

Characteristic	Hazard ratio (95% CI): unadjusted model	Hazard ratio (95% CI): minimally adjusted model ^s
Age group		
<65 years	1.67 (1.29–2.16)	1.66 (1.27–2.16)
65–74 years	1	1
75+ years	0.99 (0.79–1.24)	1.03 (0.81–1.30)
Sex		
Male	1	1
Female	0.91 (0.75–1.09)	1.00 (0.83–1.21)
Device type		
Permanent pacemaker	1	1
Implantable cardioverter defibrillator	1.52 (1.23–1.87)	1.10 (0.86–1.40)
Cardiac resynchronisation therapy pacemaker	1.68 (1.16–2.43)	1.47 (1.01–2.13)
Cardiac resynchronisation therapy defibrillator	2.70 (1.97–3.69)	1.69 (1.19–2.41)
Procedure type		
New	1	1
Revision	2.10 (1.25–3.53)	1.90 (1.13–3.19)
Replacement*	1.42 (1.17–1.72)	1.54 (1.27–1.87)
No. of previous procedures†		
0	1	1
1	1.68 (1.36–2.08)	1.69 (1.37–2.10)
2 or more	3.51 (2.49–4.95)	3.06 (2.17–4.33)
Previous device infection‡		
No	1	1
Yes	17.75 (13.58–23.20)	14.4 (10.9–18.9)
Emergency admission		
No	1	1
Yes	1.00 (0.82–1.20)	0.94 (0.78–1.14)
Private insurance		
No	1	1
Yes	0.90 (0.76–1.08)	0.99 (0.83–1.18)
Medical conditions‡		
Diabetes	1.17 (0.97–1.41)	0.91 (0.74–1.11)
Hypertension	1.04 (0.84–1.29)	0.87 (0.69–1.11)
Coronary artery disease	1.36 (1.14–1.63)	1.09 (0.89–1.34)
Congestive heart failure	2.09 (1.75–2.50)	1.36 (1.07–1.75)
Atrial fibrillation	1.45 (1.21–1.72)	1.24 (1.03–1.49)
Peripheral vascular disease	1.70 (1.42–2.04)	1.08 (0.86–1.36)
Stroke	1.30 (0.99–1.69)	1.19 (0.91–1.56)
Chronic obstructive pulmonary disease	1.55 (1.26–1.91)	1.25 (1.01–1.56)
Sleep apnoea	1.92 (1.37–2.69)	1.25 (0.87–1.78)
Chronic kidney disease	1.85 (1.55–2.22)	1.57 (1.27–1.93)
Obesity	1.65 (1.35–2.02)	1.26 (1.01–1.57)
Cardiomyopathy	2.34 (1.89–2.89)	1.57 (1.22–2.01)
Concomitant cardiac surgery		
No	1	1
Yes	1.68 (1.15–2.46)	1.59 (1.08–2.33)
Previous coronary artery bypass graft surgery‡		

Characteristic	Hazard ratio (95% CI): unadjusted model	Hazard ratio (95% CI): minimally adjusted model [§]
No	1	1
Yes	1.43 (0.81–2.54)	1.25 (0.70–2.23)
Previous valve surgery [‡]		
No	1	1
Yes	1.95 (1.28–2.96)	1.76 (1.16–2.68)
Hospital type		
Public	1	1
Private	0.93 (0.78–1.11)	1.03 (0.86–1.24)

* Replacement includes upgrade.

† Identified from all hospital records from July 2001 before the CIED procedure.

‡ Identified from the index admission with the CIED procedure and all hospital admissions in the 12 months prior.

§ The minimally adjusted models were adjusted for age, sex and medical comorbidities listed in the table.