Single tertiary center experience from Turkey regarding the experience for cardiac implantable electrical devices

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Original Article

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ABSTRACT

Objective: To present our experience of cardiac implantable electrical devices (CIED) implantation and complications in a tertiary referral centre and to compare these data with literature

Design: A retrospective observational study

Setting: Izmir Katip Çelebi Universty, Ataturk Research and Education Hospital, Turkey

Subjects: 1209 de-novo CIED patients and 50 patients who underwent revision and battery exchange procedures

Intervention: Hospital records were scanned

Main outcome measures: Compared to most other studies in literature, the population of this study was younger. The complication rate of cardiac resynchronization therapy (CRT) implantation was low, but the actual cause of 6 of the 10 mortalities could not be determined.

Results: 38.6%(n=486) of patients had a cardiac pacemaker (CPM), 53.6%(n=675) an implantable cardioverter-defibrillator (ICD), and 7.8%(n=98) CRT-D. The mean age of patients was 63.9±14.8 years, and 66.8%(n:842) were male. The main indication for ICDs was primary prevention in 715 (56.8%) patients. The main indications for CPM implantation were as follows: 234 (18.6%) complete AV block, 83 (6.6%) sick sinus syndrome. The mean LVEF value was 39.5%±16.5 before CIED implantation and 40.1%±16.1% after CIED implantation. Device infection was determined at 2.1%(n=27); pocket infection at 1.7%(n=21), pneumothorax at 0.6%(n=7) and tamponade at 30.3%(n=3). The rate of pocket hematoma was 3.4% (n=42). Mortality occurred in 10 patients. Subclavian thrombus developed in 3 patients, shock in 773, and lead dysfunction in 70 patients.

Conclusion: In contrast to general knowledge, no gender difference was determined in terms of complication rates, which were also lower than literature rates despite operation complexity. Therefore, these data present different knowledge from the data available in literature.

KEYWORDS: Cardiac implantable electrical devices, complication, implantable cardioverter defibrillator, pacemaker

INTRODUCTION

Under appropriate indications, cardiac pacemakers (CPM), implantable cardioverter-defibrillators (ICD), and cardiac resynchronization therapy (CRT), under the collective term of cardiac implantable electrical devices (CIED), have been applied in increasing numbers due to low associated risks and favorable outcomes. With increasing ageing populations worldwide, there has been a parallel increase in the prevalence of CIEDs[1]. As a result of the rapidly expanding number of patients and developments in technology, ~1 million transvenous CIEDs are now implanted annually worldwide[2].

Since CPM was first introduced in 1958, CIEDs have undergone great technological advances[3]. Nevertheless, despite the increasing complexity and the development of numerous features, the issues of CIEDs have remained similar. Indications for CIED are chronotropic incompetence or prevention of malignant arryhthmia, and complications may be acute, related to implantation, or long-term, related to the pulse generator or lead[4].

The aim of this study was to present the experience of CIED implantation and associated problems during follow-up in a tertiary health centre in Turkey.

SUBJECTS AND METHODS

Patient selection

A retrospective review was made of patients who underwent CIED implantation between January 2007 and June 2018. The cases in the study cohort were predominantly those implanted with a first cardiac device, and cases of revision and battery exchange procedures were a minority. All patient data were retrieved from the hospital medical report system archive.

For each patient, a record was made of gender, age at pacemaker implantation, indication, type and working mode of CIED, complication rates with associated causes, treatment and results, pocket hematomas, comorbid coronary arterial disease (CAD), arterial hypertension (HT), diabetes mellitus (DM), and left vetricular ejection fraction (LVEF) values before and after CIED implantation. Coronary arterial disease was defined as a history of coronary stent, coronary arterial by-pass grafting (CABG), non-critical coronary arterial disease (<50% lesion on coronary angiography), and no CAD was defined as normal coronary artery on coronary angiography. Comorbid HT and DM were defined as regulated blood pressure or blood glucose, respectively, with the use of at least one drug.

Anticoagulant therapies were classified as warfarin, rivaroxaban, apixaban, dabigatran or edoxaban, and anti-aggregant therapies as acetylsalicylic acid (ASA), clopidogrel, ticagrelor, prasugrel and ASA combination therapies.

Data were recorded with regard to application of therapy on ICD-enabled devices and the details of which arrhythmias (ventricular tachycardia (VT), ventricular fibrillation (VF), supraventricular tachycardia (SVT), atrial fibrillation (AF)) were treated before any shock therapy, and a separate record was made of appropriate (VT-VF) or inappropriate shocking (SVT-AF).

The LVEF values before CIED were accepted as persistent LVEF rate for at least three months, and LVEF of patients with a minimum value of 1 year after the procedure was accepted as the value after the CIED. Patients with no LVEF record at 1 year after the procedure were excluded from the study.

Data were also collected related to pocket hematomas, lead dysfunctions, pocket or lead infections, upgrade (CPM to ICD, CPM or ICD to CRT-D), revision (lead or pocket problems) or extraction procedures of CIEDs.

Approval for the study was granted by the Local Ethics Committee, with separate decisions for ICDs and CPMs. All procedures were performed following patient verbal and/or written informed consent.

Statistical analysis

Data obtained in the study were analysed statistically using SPSS vn. 15.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were stated as mean ± standard deviation, median and range. Categorical variables were stated as number (n) and percentage (%). A value of $p < 0.05$ was considered statistically significant.

RESULTS

The study sample comprised 1209 patients with first application of CIED and 50 patients who underwent revision and battery exchange procedures.

In the total study population, 38.6% (n = 486) of patients had a CPM, 53.6% (n = 675) had an ICD, and 7.8% (n = 98) had a biventricular ICD (CRT-D) (Table 1). In the distribution of these CIEDs, 15.1% (n = 190) of patients had dual chamber CPM (DDD-CPM), 10.2% (n = 129) had single chamber CPM (VVI-CPM), 13.3% (n = 167) had single chamber with atrial sense (VDD-CPM), 53.3% (n = 462) had single ventricular chamber ICD (VVI-ICD), 16.6% (n = 209) had dual chamber ICD (DDD-ICD), and 0.3% (n = 4) of patients had single chamber ICD with atrial sense (VDD-ICD). The mean number of leads for each patient was 1.47 ± 0.63 (Table 2).

The mean age of the whole cohort was 63.9 ± 14.8 years, and male gender was dominant at 66.8% (n = 842). The mean age was 58.9 ± 12.1 years in the CPM group, 71.1 ± 15.1 years in the ICD group, and 60.0 ± 10.4 years in the CRT group. The mean age was determined to be similar in the CPM and CRT groups, and a statistically significant difference was determined in the ICD group ($p < 0.001$) (Table 1).

Of the patients with ICD implantation, 56.8% (n = 715) had an indication for primary prevention of malignant arrhythmia and 4.0% (n:50) had an indication for secondary prevention after a documented malignant arrhythmia.

The CPM implantation indications were as follows: 18.6% (n = 234) complete atrioventricular (AV) block, 6.6% (n = 83) sick sinus syndrome (SSS), 3.6% (n = 46) symptomatic sinus bradycardia, 3.3% (n = 41) Mobitz type 2 AV block, 1.4% (n = 17) junctional rhythm, 0.8% (n = 10) symptomatic atrial fibrillation with slow ventricular response, 0.4% (n = 5) cardio-inhibitory syncope, 0.3% (n = 4) symptomatic carotid sinus hypersensitivity, and 0.3% (n = 4) Mobitz type 1 AV block (Table 3). Of this CPM group, complete AV block persisted in 2 patients after percutaneous coronary intervention, in 2 patients after electrophysiology, and in 2 patients after myocardial infarction.

In these indications, there were some intersecting sets. In the CRT-D group, implantation indication was left ventricular bundle block + LVEF≤ 35 + symptomatic sinus bradycardia in 2 patients and complete AV block with indication for primary prevention in 5 patients. Due to coronary sinus stenosis, 4 patients underwent coronary sinus balloon dilation.

In the whole CIED group, 2.5% (n = 32) of patients underwent a pacemaker revision procedure and 1.4% (n = 18) of patients underwent CIED battery exchange due to replacement indication (Table 3).

The mean LVEF value before CIED implantation was 39.5% ± 16.5%, and mean LVEF value at 1 year after CIED implantation was 40.1% ± 16.1% for all groups. There was no statistical difference. For the ICD and CRT-D patients, who had a CIED implantation for primary prevention, the mean LVEF value was 28.07% ± 9.73% before CIED implantation, and the mean LVEF increased to 29.22% ± 10.09% after CIED implantation ($p < 0.001$). There was a statistically significant difference regarding LVEF increase for these groups, but not at a level to indicate changing the ICD implantation.

Arterial hypertension was the most frequent comorbid disease at 61.9% (n = 779), DM was detected at the rate of 17.6% (n = 221), and CAD at 59.2% (n = 745). The clinical distribution of CAD was as follows: non-critical CAD 16.1% (n = 203), CABG history 14.7% (n = 185), coronary stent implantation 22.0% (n = 277),

and inoperable multiple vessel, serious CAD history 6.4% (n = 80). In 17.2% (n = 216) of patients, the coronary artery was observed to be normal on coronary angiography. No statistically significant difference was determined between all the groups(CPMs, ICDs,CRT-Ds) in respect of DM comorbidity, but for CAD and HT, there were statistically low rates in the CPM group (p = 0.94 for DM, p <0.001 for CAD, p = 0.07 for HT) (Table 1).

In respect of complications, local infections, such as device infections needing extraction of all the leads, the generator and antibiotic therapy were seen in 2.1% (n = 27) of the patients. Pocket infection requiring hospitalization with treatment of IV or oral antibiotherapy only was determined in 1.7% (n = 21) of patients, pneumothorax in 0.6% (n:7) and pericardial/cardiac tamponade in 0.3% (n = 3). No statistically significant difference was determined between the groups in respect of pneumothorax and pericardial/cardiac tamponade complications (CPMs, ICDs, CRT-Ds) (p = 0.75 for pneumothorax, p = 0.32 for tamponade). Both local and device infections were determined at statistically significantly lower rates in the CRT-D group (p = 0.001 for local infections, p =0.001 for device infections) (Table 4).

Battery pocket hematoma was detected in 3.4% (n = 42) of patients, 32 of which were treated with the application of a heavy object such as a sandbag on the battery pocket, and 10 were treated with percutaneous draining of the hematoma from the pocket with a syringe. No statistically significant difference was determined between the groups (CPMs, ICDs, CRT-Ds) in respect of the rate of pocket hematomas (p = 0.44).

Mortality developed in 10 patients during the hospitalisation period after CIED implantation. The reason for mortality could not be detected in 6 cases, in all of which the general condition deteriorated after the procedure and death occurred in intensive care follow-up. In the other 3 mortality cases, 3 occured due to pneumosepsis and 1 due to pericardial/cardiac tamponade.

During the follow-up period after CIED implantation, 3 patients developed subclavian thrombus. All 3 cases developed unilateral upper extremity edema. One patient was VVI-ICD and thrombus was detected in the first week. One of these was DDD-ICD and thrombus was detected in the fourth week, and the other was VVI-CPM and thrombus was detected in the second month. The first case with thrombus detected in the first week was treated with low-dose alteplase (t-Pa) infusion (25 mg for 25 hours), and the other 2 were administered anticoagulants of coumadin-warfarin with 2-3 INR value.

During the follow-up period of CIED implantation, some ICD patients received therapeutic shock; 4.5% (n = 35) of patients received appropriate shocks for ventricular tachycardia and 0.8% (n = 6) for ventricular fibrillation. Inappropriate shocks were received by 2.5% (n = 19) of patients for supraventricular tachycardia, by 1.8% (n = 14) for atrial fibrillation, and by 0.2% (n = 2) for external noise (Table 5).

No ICD shocks were reported by 90.2% (n = 697) of patients during follow-up. In the total CIEDs, lead dysfunction was determined during the follow-up period in 5.6% (n = 70) of patients, because of symptoms such as inappropriate shocks, CPM dysfunction or muscle stimulation due to pacing (Table 4,5). Lead revision was applied to 32 cases, and in the other 38 cases, the problem was resolved with re-programming of the CIED. Statistically significant differences were determined between the CPM and ICD/CRT-D groups in respect of lead dysfunction (p <0.001) and the difference was greater in the CPM group (n = 531 vs. 657).

Two patients underwent left ventricular assist device implantation, and 3 patients underwent cardiac transplantation during the follow-up period.

DISCUSSION

Following the first successful cardiac electrostimulation, the development of modern CIEDs started in the early 19th century[5]. In 1869, rhythm control could be performed via external electrical energy application to the precordium of a patient with tachycardia. This was possibly the first report of external cardioversion[6].

Over the years, temporary pacing in humans became successful[7]. In 1952, Madsen *et al* described a precordial plate and oesophageal electrode which could pace the heart for emergent cases[8]. In 1958, Furman *et al* described an externally powered transvenous bipolar catheter[9].

With advancements in techology, Larsson *et al* presented the first epicardial leads and self-contained pacemaker[10].

After all these steps in CIED technologies, current modern cardiology can manage to treat symptomatic bradycardia, prevent sudden cardiac death, and reduce heart failure symptoms with the use of CPMs, ICDs, and, CRT-Ds.

The increasing aging population has led to increasing numbers of CIEDs used in modern cardiology over recent decades[11].

According to the data of this study, our hospital has a year-on-year increasing number of CIED implantations, revisions and battery replacements. These numbers are expected to increase further due to changes in the healthcare reimbursement procedures, and that more patients from all over the Aegean region in Turkey are being referred to our hospital.

In this study, a retrospective examination was made of 1259 patients with cardiac device (CPM, ICD and, CRT-D) implantation, revision or replacement applied between January 2007 and June 2018. The aim of the study was to present the experiences of our CIED procedures, patient features, and complication rates/results. Male gender was seen to be predominant overall (66.8%, n = 841), which was consistent with the findings of other studies[12,13]. However, there were more females in the ICD group with 252 female to 234 male patients. This could be partly related to the overall increase in referral rates of female patients from other hospitals to avoid the known higher complication rates[15] and concern for higher hospital costs. The gender distribution of the other groups was compatible with the male predominance of the total patient population (539 male to 132 female in CPM group, 68 male to 30 female in CRT-D group). The overall mean age of the patients was 63.9 ± 14.8 years, which was younger than ages reported in other studies. In those previous studies, ~ 80% of CIEDs were implanted in patients aged >70 years, with a mean age of 74 years[14,15]. The younger mean age could be explained by the overall younger population age, and due to limited medical resources, perhaps only the younger patients have access to such therapy. The overall mean age of the current study is similiar to the 63±14 years reported in a study of pocket hematomas in Turkey by Demir *et al*[16]. The mean age of patients in the CPM and CRT groups was determined to be statistically similar but in the ICD group an older mean age was identified (CPM = 58.9 ± 12.1 years; ICD = 71.1 ± 15.1 years; CRT = 60.0 ± 10.4 years; p <0.01).

Of the total patients in the current study, 38.6% (n = 486) had a CPM, 53.6% (n = 675) had an ICD, and 7.8% (n = 98) had a CRT-D. The mean age was 71.1 ± 15.1 years in the ICD group, 61.6 ± 10.2 years in the CRT-D group, and 58.9 ± 12.9 years in the CRT-D group. As CAD and low LVEF are known to increase with aging, it is to be expected that the ICD group would be older than the CPM group and the CRT-D group would be younger than the ICD group, as life expectancy is longer for young patients with r CRT.

The most frequent comorbid disease in the current cohort was found to be HT (61.9%, n = 77), which was similiar to the rate of 72.8% reported by Demir *et al*[16].

In the current study, indications for CPM implantation were as follows: 18.6% (n = 234) complete AV block, 6.6% (n = 83) SSS, 3.6% (n = 46) symptomatic sinus bradycardia, 3.3% (n = 41) Mobitz type 2 AV block, 1.4% (n = 17) junctional rhythm, 0.8% (n = 10) symptomatic atrial fibrillation with slow ventricular response, 0.4% (n = 5) cardio-inhibitory syncope, 0.3% (n = 4) symptomatic carotid sinus hypersensitivity, and 0.3% (n = 4) Mobitz type 1 AV block. This distribution was similiar to the rates reported by Proclemer *et al*, of 45% AV conduction disturbances, and 25% SSS[14]. In the current study, atrioventricular synchrony mode (DDD-CPM 15.1%, n = 190, and VDD-CPM 13.3%, n = 167) was preferred more frequently than asynchronous mode (VVI-CPM 10.2%, n = 129), which was consistent with the findings of Coma *et al*[17], but unlike those in the study by Proclemer *et al*[14] and Aktoz *et al*[12]. In those two studies there was a higher rate of VVI mode than DDD mode.

In the ICD group, primary prevention indication was more frequent than secondary prevention indication (56.8%, n = 715 vs. 4.0%, n = 50), and 14 patients underwent ICD implantation for hypertrophic cardiomyopathy. One patient in the ICD group had Brugada syndrome, 1 had arrhythmogenic right ventricular dysplasia, and 1 had permanent low LVEF after Takotsubo syndrome. These data were compatible with those of the study by Proclemer *et al*[18], where more frequent primary prevention rates were also determined. There could also be an association with the aim of clinicians to protect the societally more active young population from sudden cardiac events. In the current study, there was a higher rate of VVI-ICD than DDD-ICD (53.3%, n = 462 vs. 16.6%, n = 209) as VVI-ICD is preferred in our centre for primary prevention of malignant arrhythmias, and this finding was compatible with the Israeli ICD Registry result[19]. In the Israeli ICD Registry, there was reported to be no difference between VVI-ICD and DDD-ICD in reducing mortality rates or heart failure episodes and inappropriate shock application.

The total infection rate in the current study was 3.8%, including device infections (2.1%, n = 27) and local infections (1.7%, n = 21). This rate is higher than the data of previous studies. According to literature, the risk of CIED infection is 0.5% after new implantation, and ~ 1–5 % after replacement or revision[20,21]. The hematoma rate was 3.4% (n = 42), pneumothorax 0.6% (n = 7) and pericardial/cardiac tamponade 0.3% (n = 3). No significant difference was determined between the genders in respect of all the complications (device infection p = 0.98; local infection p = 0.98; hematoma p = 0.28; pneumothorax p: = 0.17; tamponade p = 0.47). According to literature, females are at higher risk of developing pneumothorax and tamponade[15]. No statistically significant difference was determined between all the groups (CPMs, ICDs, CRT-Ds) in respect of pocket hematomas, pneumothorax and pericardial/cardiac tamponade (p:0.44 for hematomas, p:0.75 for pneumothorax, p:0.32 for tamponade). Both local and device infections had statistically significantly lower rates in the CRT-D group (p = 0.001 for local infections, p = 0.001 for device

infections). This differences originated between CPM via CRT-D (p = 0.075). It has been reported in literature that larger and more rigid defibrillator leads constitute an increased risk for complications[22]. In this context, the current study data are controversial as lower complication rates were determined in the CRT-D group, but this can be attributed to more experienced surgeons performing CRT-D implantation in our center.

Hematoma was detected in 3.4% (n = 42) of patients, with no statistically significant difference determined between all the groups (CPMs, ICDs, CRT-Ds) in respect of pocket hematomas (p = 0.24). Although this finding is similiar to the rate reported by Demir *et al*[16], larger series such as in the study by Sridhar *et al*[23] with 1677 hematomas, have shown that the complexity of CIED is associated with more frequent hematomas (CRT>DDD>VVI)

On the defibrillator CIEDs, a total of 41 (5.3%) patients received appropriate shock (35 patients for VT and 6 patients for VF) and 35 (4.5%) received inappropriate shock (19 patients for SVT, 14 patients for AF and 2 patients for external noise or T wave oversensing). Wide ranges have been reported in literature, with a meta-analysis stating inappropriate shocks in 10% - 24% of patients and appropriate ICD therapies in 17-64% of patients[24]. The rates in the current study were low in comparison to previously reported values. This can be associated with shocks not felt by the patient or it could be related to patient follow-up continuing at a different center.

Lead dysfunction was determined in 5.6% (n = 70) of patients in the current study through the detection of inappropriate shocks, pacing dysfunction or diaphragmatic stimulation of cardiac pacemaker. Lead revision was required in 32 cases, and in the other 38 patients the problem was resolved by re-programming. There is a reporting bias about lead dysfunction, with a range of 0.28% to 1.14% reported in one study[25] and up to 40% in another[26]. Statistically significant differences were determined between the CPM and ICD/CRT-D groups in respect of lead dysfunction (p <0.001) and the difference was greater in the CPM group (n = 531 vs. 657).

A previous study in Japan reported that only 0.3% of patients (1 patient in 330 transvenous permanent cases) suffered upper extremity thrombosis due to pacemaker implantation[26]. In the current study, 3 patients were determined with subclavian thrombus after CIED (1 VVI-ICd, 1 DDD-ICD, 1 VVI-CPM). Of these cases, 2 were treated with anticoagulation and 1 with low dose fibrinolytic therapy.

Mortality following CIED implantation is rare and has been reported at rates of 0.08-1.1%[27]. When mortality occurs, it is frequently due to cardiac or major vascular perforation or massive hemopneumothorax. In the current study, mortality occurred in 10 (0.79%) patients after CIED implantation; 3 because of pneumosepsis, 1 because of pericardial/cardiac tamponade, and in the other 6 patients, the exact cause of mortalitiy could not be determined, although with a deteroration in the general condition after the procedure, there could have been an association with pulmonary embolization.

CONCLUSION

This is a single center experience for overall CIED implantations. Some of the complications rates in this study are lower compared to published data, which can be attributed to the fact that complex CIED implantations are performed by more experienced surgeons in our centre. The mortality rate was within the

published range. In contrast to the current general knowledge, no difference was determined between the genders in respect of complication rates and our center had a younger population than that reported in most studies.

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E.O data design, collection, writing; M.P.A. data collection, S.V.E statistical analysis; C.N.,and M.T. review

Study limitations: Limitations of the study mostly related to the retrospective nature of the study and that the data were collected from a single center database. Therefore, the findings do not reflect the experience of other pacing centres.

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Table 1: General data and comorbid diseases of patients

Variable	CIED without defibrillation function	CIED with defibrillation function		Total	p-value
	CPMs	ICDs	CRT-Ds		
Number of patients	486	675	98	1259	
Mean age (years)	58.9±12.1	71.1±15.1	60.0±10.4	63.9 ± 14.8	<0.001
Gender (Male/Female)	234/252	540/135	68/30	842/417	<0.001
HT	396	306	77	779	0.07
DM	115	87	19	221	0.94
CAD					<0.001
- Normal coronary	123	64	29	216	
- Non-critical CAD	102	75	26	203	
- Operated CABG	136	33	16	185	
- Inoperable multiple vessel-serious CAD	198	61	18	277	

CAD: coronary arterial disease; HT: arterial hypertension; DM: diabetes mellitus; CABG: coronary arterial by-pass grafting; CIED: cardiac implantable electronic device

Table 2: Mode of CIEDs

CIED	Number, percentage
VVI-CPM	n:129; 10.2%
DDD-CPM	n:190; 15.1%
VDD-CPM	n:167; 13.3%
VVI-ICD	n:462; 53.3%
DDD-ICD	n:209: 16.6%
VDD-ICD	n:4; 0.3%
CRT-ICD	n:98; 7.8%

CIED: cardiac implantable electronic device, CPM: cardiac pacemaker, ICD: implantable cardioverter defibrillator

Table 3: CIED procedure indications

Variable	Number	Percentage (%)
Complete AV block	234	18.6
ICD primary prevention	715	56.8
Sick sinus syndrome	83	6.6
ICD secondary prevention	50	4.0
Symptomatic sinus bradycardia	46	3.6
Mobitz type 2 AV block	41	3.3
CIED revision	32	2.5
ERI/EOL. CIED Replacement	18	1.4
Junctional rhythm	17	1.4
Symptomatic atrial fibrillation with slow ventricular response	10	0.8
Cardio-inhibitory syncope	5	0.4
Mobitz type 1 AV block	4	0.3
Carotid sinus hypersensitivity	4	0.3
Total	1259	100.0

AV: atrioventricular; ICD: implantable cardioverter defibrillator; EOL: end of life; ERI: elective replacement indication; CIED: cardiac implantable electronic devices

Table 4: CIED complications

Variable	CIED without defibrillation function	CIED with defibrillation function		p-value
	CPMs	ICDs	CRT-Ds	
Device infections	20	6	1	0.001
Local/Pocket infection	16	5	0	0.001
Pneumothorax	3	3	1	0.75
Tamponade	2	1	1	0.32
Pocket hematoma	14	27	1	0.44
Subclavian thrombus	1	2	0	-
Lead dysfunction	43	18	9	<0.001

Table 5: Shock record/status of defibrillator CIEDs during the follow-up period

Shock status	Number	Percentage
None	697	55.3
Appropriate shocks for VT	35	2.8
Appropriate shocks for VF	6	0.5
Inappropriate shocks for SVT	19	1.5
Inappropriate shocks for AF	14	1.1
Inappropriate shocks for any external noises*	2	0.2
Total	1259	100.0

VT: ventricular tachycardia; VF: venticular fibrillation; SVT: supra- ventricular tachycardia; AF: atrial fibrillation

* External noise: an oversensed wave due to external electromagnetic energy, far-field R-waves or electrical activity of the musculoskeletal system=noise which is secondary to lead or battery dysfunction