Current clinical practice of cardiac resynchronization therapy in Turkey: Reflections from Cardiac Resynchronization Therapy Survey-II

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Abstract

Objective: Cardiac resynchronization therapy (CRT) has been shown to reduce mortality in selected patients with heart failure with reduced ejection fraction (HFrEF). CRT Survey-II was a snapshot survey to assess current clinical practice with regard to CRT. Herein, we aimed to compare Turkish data with other countries of European Society of Cardiology (ESC).

Methods: The survey was conducted between October 2015 and December 2016 in 42 ESC member countries. All consecutive patients who underwent a de novo CRT implantation or a CRT upgrade were eligible.

Results: A total of 288 centers included 11,088 patients. From Turkey, 16 centers recruited 424 patients representing 12.9% of all implantations. Compared to the entire cohort, Turkish patients were younger with a lower proportion of men and a higher proportion with ischemic etiology. Electrocardiography (ECG) showed sinus rhythm in 81.5%, a QRS duration of <130 ms in 10.1%, and ≥150 ms in 63.8% of patients. Left bundle branch block (LBBB) was more common. Median left ventricular ejection fraction (LVEF) was 25%, lower than in the overall ESC cohort, but NYHA class was more often II. Most common indication for CRT implantation was HF with a wide QRS (70.8%). Almost 98.3% of devices implanted were CRT-D, in contrast to the overall cohort. Fluoroscopy time was longer, but duration of overall procedure was shorter. LV lead implantation was unsuccessful in 2.6% patients. Periprocedural complication rate was 6.3%. The most common complication was bleeding. Remote monitoring was less utilized.

Conclusion: These are the first observational data reflecting the current CRT practice in Turkey and comparing it with other countries of Europe. Findings of this study may help detect gaps and provide insights for improvement. *(Anatol J Cardiol 2020; 24: 382-96)*

Keywords: cardiac resynchronization therapy, epidemiological survey, heart failure

Introduction

Cardiac resynchronization therapy (CRT) has been revolutionary in medically refractory, symptomatic heart failure (HF) patients with reduced ejection fraction and a prolonged, abnormal QRS complex. The HF patients are identified based on clinical, electrocardiographic, and imaging criteria recommended by the European Society of Cardiology (ESC) guidelines (1, 2). The technology behind CRT rests on the link between electrical dyssynchrony and left ventricular (LV) function demonstrated in 1990s (3). First clinically used in 1994 (4), today CRT is a safe and effective treatment strategy that has been shown to lower mortality and hospitalization in indicated HF patients (5, 6). A concomitant implantable cardioverter-defibrillator (ICD) is recommended to prevent sudden cardiac death with stronger level of evidence in ischemic than nonischemic HF etiology.

In 2012, the Heart Failure Prevalence and Predictors in TurkeY (HAPPY) study reported that the prevalence of HF among adults aged ≥ 35 years in Turkey was 2.9% (7). The Snapshot Evaluation of Heart Failure Patients in Turkey (SELFIE-TR) survey conducted in 2015, which included 1.054 HF patients in Turkey, reported that 5.1% were implanted with a CRT (8). Currently, there are no data in the literature that focuses on periprocedural characteristics of Turkish HF patients hospitalized for CRT implantation.

CRT Survey-II was a snapshot survey to assess current clinical practice with regard to CRT in a large sample size from a broad geographical area (9). The data obtained from the survey were expected to reflect on implanting hospital facilities and patient characteristics, preimplantation assessment, implantation procedure, postimplantation follow-up during hospitalization, and discharge management. Its results were published in 2018 (10). In this study, we aimed to present the practice of CRT implantation in Turkey obtained from CRT Survey-II data and compare it with other European countries.

Methods

CRT Survey-II was designed and conducted as a joint project of the European Heart Rhythm Association (EHRA) and Heart Failure Association (HFA) (9).

Survey population

A survey of the clinical practice of CRT-pacemaker (CRT-P) and CRT-defibrillator (CRT-D) implantation was conducted between October 1, 2015 and December 31, 2016 in 42 ESC member countries. All consecutive patients who underwent a *de novo* CRT implantation or an upgrade CRT procedure of previously implanted ICD or permanent pacemaker (PPM) were included. Generator replacements or revisions of existing CRT devices were excluded.

Data collection and management

CRT Survey-II included two internet-based questionnaires. Each implanting center was requested to complete a one-time site questionnaire prior to inclusion of the first patient. This provided information on hospital type, size, population served, operator specialty, infrastructure, facilities, and implantation routines for their CRT device program. The data collected also provided information related to healthcare resource utilization.

Implanting centers were asked to complete a web-based electronic case report form (eCRF) for consecutive patients scheduled to receive a CRT. The eCRF included information regarding patient characteristics, etiology of HF, comorbidities, electrocardiogram (ECG) features, imaging information, indication for CRT implantation, procedural details, device programing, periprocedural complications, and follow-up plans. Data from unsuccessful CRT implantations were also included.

Data collection, management, and analysis were organized by IHF GmbH Institut für Herzinfarktforschung (Ludwigshafen). No imputation for missing data was done. All percentages are presented relative to the total number of patients with available information.

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Absolute numbers and percentages were shown for categorical variables. Means (with standard deviations) or medians (with interquartile range) were used for continuous variables. Categorical variables were compared between subgroups by the Chi-square test and continuous variables by the Mann-Whitney-Wilcoxon test. A level of $p<0.05$ was assumed to be statistically significant for these tests. All statistical analyses were performed using SAS statistical software (version 9.1, Cary, NC, USA).

Results

The CRT Survey-II enrolled 11,088 patients from 288 centers in 42 ESC member countries. 424 patients from 16 centers were recruited from Turkey.

Hospital demographics

Characteristics of participating centers with regard to their hospital facilities, annual cardiac interventional activities, and CRT implanter profiles are provided in Table 1.

In Turkey, university hospitals accounted for 60% of participating centers. All centers in Turkey had angiography, percutaneous coronary intervention (vs. 95.7%, p=0.414), and cardiac surgery (vs. 67.6%, p=0.008) facilities on site. As per stated hospital statistics, annual cardiology activity in terms of CRT and PPM implantation differed between Turkey and other European centers. Median number of CRT implantations per year in sites participating the survey was significantly lower in Turkey (34 vs. 53, p=0.029), particularly due to lower median annual CRT-P implantation number (2 vs. 15, p<0.001). Annual PPM implantation was less in Turkey compared to other countries (64 vs. 269, p<0.001). In contrast, the number of ICD implantation per year was similar in Turkey and Europe (60 vs. 80, p=0.377). All centers in Turkey had reimbursement from public health providers (vs. 98.5%, p=0.628). It was found that there was less utilization of device remote monitoring in Turkey compared to other European countries (26.7 vs. 72.8%, p<0.001) (Table 1).

Patient characteristics

Baseline characteristics of the survey participants are shown in Table 2.

Patients included in this study were significantly younger in Turkey (mean age: 63.6 vs. 68.7 years, p<0.001), and nearly half of them were under 65 years. Approximately, three-quarters of patients were male (71.6 vs. 75.9%, p=0.044); 82.5% of patients were electively admitted (vs. 76.7%, p=0.006). Referrals from nonimplanting centers accounted for 22% of patients (vs. 25.5%, p=0.113). Half of the patients had ischemic HF (51.4 vs. 44.2%, p<0.001). Hypertension (57.1 vs. 64.1%, p=0.003) and atrial fibrillation (AF) (21.8 vs. 41.6%, p<0.001) were less common among Turkish patients. It was found that nearly one-third of Turkish patients had valvular heart disease (32.9 vs. 26.9%, p=0.007), and nearly one-fifth had undergone valve surgery/procedure (17.1 vs. 32.2%, p<0.001); 10.9% had obstructive lung disease (vs. 12.1%, p=0.463) and 31.8% had diabetes mellitus (DM) (vs. 31.4%, p=0.869). Anemia was more common (24.9 vs. 14.6%, p<0.001), and chronic kidney disease (CKD) was less prevalent (25.2 vs. 31.4%, p=0.007) among Turkish patients. More than half of the patients were hospitalized for HF during the past year (52.4 vs. 46.3%, p=0.014). Nearly one-sixth of the Turkish patients (15.2%) had previous device implantation (vs. 23.5%, p<0.001), three-quarters of them (75.0%) were ICDs (Table 2).

Preimplantation clinical, laboratory, and ECG characteristics of survey participants are provided in Table 3.

The Turkish patients had lower body mass indices (BMI) (mean: 26.3 vs. 27.9 kg/m^2, p<0.001). They were more commonly found to be either underweight (3.1 vs. 0.9%, OR: 3.63, 95% CI: 2.01–6.56) or within normal BMI limits (35.5 vs. 27.6%, OR: 1.44, 95% CI: 1.18–1.77) compared to the other European countries. Most Turkish patients were classified as New York Heart Association (NYHA) functional class II or III (91.4%). Natriuretic peptide levels were generally substantially elevated (median BNP: 545 and median NT-proBNP: 600 pg/mL). The ECG at the time of implantation showed AF in 15.9%, a QRS duration of <130 ms in 10% and ≥150 ms in 63.8% of patients, and 79.1% had left bundle branch block (LBBB). In other European countries, a baseline QRS duration of <130 ms was found in 12.8%, ≥150 ms in 68.8% patients, and 72.5% had LBBB. A normal QRS morphology was less frequently encountered among the Turkish patients (2.9 vs. 7.4%, p<0.001). Among patients with AF, atrioventricular node ablation was either performed or planned in 26.9% (vs. 30.4%, p=0.533) (Table 3).

Preimplantation imaging assessment of survey participants are shown in Table 4.

For preprocedural assessment, echocardiography was utilized as the primary diagnostic imaging mode in nearly all Turkish patients (99.8 vs. 97.6%, p=0.004). In majority of cases (95.7 vs. 92.2%, p=0.007), LV ejection fraction (LVEF) was determined using echocardiography. Median LVEF was 25% (vs. 30%, p<0.001); 3.1% of patients had an LVEF >35% (vs. 13.4, OR: 0.21, 95% CI: 0.12–0.36) and 46.4% had either moderate or severe mitral regurgitation (vs. 32.8%) (Table 4).

The clinical indication for CRT implantation was HF with a wide QRS in 70.8% of cases (vs. 59.5%, p<0.001), HF or LV dysfunction and indication for an ICD in 51.5% (vs. 47.7%, p=0.123). In 9.7% of patients, the sole clinical indication for CRT was HF and a PPM indication with expected right ventricular (RV) pacing dependence (vs. 23.4%, p<0.001).

CRT implantation procedure and complications

In Turkey, a total of 418 patients had successful CRT implantations and 99% at the time of first attempt. In other European countries, a total of 10,380 patients had successful implantation and 99.3% at the time of first attempt. 8 of 426 CRT implantation attempts were unsuccessful due to unsuccessful LV lead placement (n=7) and pericardial tamponade (n=1).

Table 1. Characteristics of participating centers with regard to hospital facilities, annual cardiac interventional activities, and CRT implanter profiles

	Centers in Turkey (n=16)	Other European centers (n=272)	*P*-value
Hospital facilities			
Total number of hospital beds	600 (300, 999) (n=15)	605 (364, 955) (n=256)	0.730
Number of cardiology department beds	35 (30, 65) (n=15)	58 (34, 80) (n=257)	0.149
Type of hospital			
University hospital	60.0% (9/15)	59.1% (153/259)	0.661
Teaching hospital (non-university)	13.3% (2/15)	23.9% (62/259)	
Community hospital	0.0% (0/15)	10.4% (27/259)	
Private hospital	26.7% (4/15)	6.6% (17/259)[a]	
Cardiac surgery on site	100.0% (15/15)	67.6% (175/259)	**0.008***
Angiography/PCI on site	100.0 % (15/15)	95.7% (247/258)	0.414
Number of catheterization labs	2 (1, 3) (n=15)	2 (1, 3) (n=259)	0.857
Number of dedicated EP labs	1 (0, 1) (n=15)	1 (1, 2) (n=258)	**0.020***
Other sites where device is implanted	37.5% (6/16)	49.3% (134/272)	0.360
Hybrid	6.7 % (1/15)	25.3% (65/257)	0.102
Surgical	20.0 % (3/15)	27.6% (71/257)	0.519
Radiology	20.0 % (3/15)	7.4% (19/257)	0.082
Annual cardiac activity profile			
Coronary angiograms per year	2250 (1400, 3000) (n=15)	1950 (1250, 2690) (n=252)	0.373
PCI procedures per year	882 (500, 1250) (n=15)	1000 (690, 1376) (n=252)	0.325
CRT implantations per year	34 (20, 55) (n=15)	53 (30, 100) (n=255)	**0.029***
CRT-D implantations per year	25 (18, 47) (n=15)	32 (20, 74) (n=255)	0.292
CRT-P implantations per year	2 (0, 10) (n=15)	15 (6, 30) (n=255)	**<0.001***
ICD implantations per year	60 (30, 100) (n=15)	80 (40, 137) (n=256)	0.377
Pacemaker implantations per year	64 (45, 89) (n=15)	269 (191, 400) (n=256)	**<0.001***
Arrhythmia ablations per year	133 (60, 200) (n=15)	200 (80, 400) (n=255)	0.218
CRT implanter profile			
Electrophysiologists	1 (1, 4) (n=15)	2 (1, 4) (n=256)	0.233
Interventional cardiologists	2 (0, 4) (n=14)	0 (0, 4) (n=256)	0.117
Heart failure physicians	0 (0, 1) (n=14)	0 (0, 2) (n=255)	0.484
Cardiac surgeons	0 (0, 1) (n=14)	0 (0, 1) (n=253)	0.934
Others			
Source of reimbursement for CRT			
Public health provider	100.0 % (15/15)	98.5 % (255/259)	0.628
Private insurance	26.7 % (4/15)	10.8 % (28/259)	0.063
Private payer	20.0 % (3/15)	6.6 % (17/259)	0.052
Dedicated lead extraction/management program	46.7 % (7/15)	45.1 % (116/257)	0.908
Follow-up, n (%)			
Heart failure clinic	60.0 % (9/15)	68.6 % (177/258)	0.487
Dedicated CRT clinic	66.7 % (10/15)	58.5 % (151/258)	0.533
Remote device monitoring service	26.7 % (4/15)	72.8 % (187/257)	**<0.001***
Implanting center	100.0 % (15/15)	93.0 % (239/257)	0.289

Data presented as median (25th percentile, 75th percentile) or n (%). *Statistical significance. [a]Statistical significance for this row, calculated using the odds ratios including 95% confidence intervals.
CRT - cardiac resynchronization therapy; CRT-D - cardiac resynchronization therapy defibrillator; CRT-P - cardiac resynchronization therapy pacemaker; EP - electrophysiology; ICD - implantable cardioverter defibrillator; PCI - percutaneous coronary intervention

Procedural details of survey participants with successful CRT implantation are given in Table 5.

In Turkey, only 1.7% patients were implanted with CRT-P (vs. 31.4%, p<0.001) and the rest of the patients with CRT-D. The primary operator was mostly an electrophysiologist, though less common compared to other European countries (71.8 vs. 77.2%, OR: 0.75, 95% CI: 0.60–0.93). Invasive cardiologists were more (27.8 vs. 11.7%, OR: 2.89, 95% CI: 2.32–3.61)

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Table 2. Baseline characteristics of the survey participants

	Patients in Turkey (n=424)	Patients in other European centers (n=10.664)	*P*-value
Demographics			
Age, years	63.6±11.3, n=422	68.7±10.7, n=10617	**<0.001***
Age< 65	48.8% (206/422)	30.8% (3272/10617)[α]	
65≤ Age <75	35.8% (151/422)	36.5% (3874/10617)	
Age ≥75	15.4% (65/422)	32.7% (3471/10617)[α]	
Gender: male	71.6% (302/422)	75.9% (8064/10630)	**0.044***
Elective admission	82.5% (348/422)	76.7% (8074/10524)	**0.006***
Referral from another center	22.0% (93/422)	25.5% (2677/10516)	0.113
Currently enrolled in a clinical trial	8.3% (35/421)	8.3% (883/10607)	0.994
Primary HF etiology			
Ischemic	51.4% (217/422)	44.2% (4658/10531)[α]	**<0.001***
Nonischemic	48.1% (203/422)	49.9% (5250/10531)	
Past medical history and comorbidities			
Myocardial infarction	42.4% (179/422)	36.0% (3778/10504)	**0.006***
Prior revascularization (PCI/CABG)	48.6% (205/422)	38.5% (4040/10502)	**<0.001***
Hypertension	57.1% (241/422)	64.1% (6721/10478)	**0.003***
Atrial fibrillation	21.8% (92/422)	41.6% (4367/10498)	**<0.001***
Type of atrial fibrillation			0.984
Paroxysmal	25.0% (23/92)	34.9% (1525/4367)[α]	
Persistent	41.3% (38/92)	21.9% (956/4367)[α]	
Permanent	33.7% (31/92)	42.5% (1858/4367)	
Missing	0.0% (0/92)	0.6% (28/4367)	
Valvular heart disease	32.9% (139/422)	26.9% (2829/10498)	**0.007***
Valve surgery/procedure	17.1% (30/175)	32.2% (1151/3570)	**<0.001***
Aortic valve replacement	46.7% (14/30)	62.6% (720/1151)	0.077
Mitral valve replacement	60.0% (18/30)	27.2% (313/1151)	**<0.001***
Mitral valve repair	13.3% (4/30)	19.2% (221/1151)	0.419
Other	6.7% (2/30)	10.8% (124/1151)	0.472
Obstructive lung disease	10.9% (46/422)	12.1% (1269/10500)	0.463
Diabetes	31.8% (134/422)	31.4% (3294/10499)	0.869
Anemia	24.9% (105/422)	14.6% (1535/10494)	**<0.001***
Chronic kidney disease (eGFR <60)	25.2% (106/421)	31.4% (3289/10486)	**0.007***
Dialysis	3.8% (4/106)	2.8% (93/3272)	0.572
HF hospitalization during past year	52.4% (221/422)	46.3% (4857/10495)	**0.014***
Previous device implantation	15.2 (60/395)	23.5 (2338/9936)	**<0.001***
PPM	25.0 (15/60)	61.8 (1445/2338)	**<0.001***
ICD	75.0 (45/60)	38.9 (910/2338)	**<0.001***

Data are presented as mean±standard deviation or n (%). *Denotes statistical significance. [α]Indicates statistical significance for this row, calculated using the odds ratios including 95% confidence intervals.
CABG - coronary artery bypass grafting; CRT-D - cardiac resynchronization therapy defibrillator, CRT-P - cardiac resynchronization therapy pacemaker; eGFR - estimated glomerular filtration rate; HF - heart failure; ICD - implantable cardioverter-defibrillator, PCI - percutaneous coronary intervention; PPM - persistent pacemaker

and HF physicians were less (0.5 vs. 5.2%, OR: 0.09, 95% CI: 0.02–0.35) involved in CRT implantation as primary operators. Duration of the procedure was shorter (median: 71 vs. 90 min, p<0.001), but the fluoroscopy time was longer (median: 18 vs. 14 min, p<0.001). Test shock was less commonly applied (1.9 vs. 4.9%, p=0.006). The prevalence of the LV lead being the first placed lead was lower (6.7 vs. 16.8%, p<0.001). RV lead was placed to the RV apex in most of the cases (88.7 vs. 60.1%, OR: 5.21, 95% CI: 3.81–7.13), placement of the RV lead to the interventricular septum was less common (10.3 vs. 37.5%, OR: 0.19, 95% CI: 0.14–0.26). Among patients with successful LV lead placement (97.4 vs. 99.5%, p<0.001), 12.0% had epicardial lead

Table 3. Preimplantation clinical, laboratory, and electrocardiographic characteristics of survey participants

	Patients in Turkey (n=424)	Patients in other European centers (n=10.664)	*P*-value
Preimplantation clinical evaluation			
NYHA class			
I	2.6% (11/422)	3.4% (359/10426)	**0.007***
II	46.9% (198/422)	37.3% (3885/10426)[a]	
III	44.5% (188/422)	54.9% (5721/10426)[a]	
IV	5.9% (25/422)	4.4% (461/10426)	
BMI, kg/m^2	26.3±4.6 (n=414)	27.9±5.0 (n=10060)	**<0.001***
Underweight: BMI <18.5	3.1% (13/414)	0.9% (89/10060)[a]	
Normal weight: 18.5≤ BMI <25	35.5% (147/414)	27.6% (2777/10060)[a]	
Overweight: 25≤ BMI <30	42.3% (175/414)	41.6% (4183/10060)	
Obesity: BMI ≥30	19.1% (79/414)	29.9% (3011/10060)[a]	
Diastolic blood pressure, mmHg	75.5±12.1 (n=422)	73.6±11.4 (n=10280)	**<0.001***
Systolic blood pressure, mmHg	123.6±19.4 (n=422)	124.8±18.9 (n=10283)	0.151
Preimplantation laboratory assessment			
NT-proBNP, pg/mL	600 (229, 1914) (n=55)	2444 (1082, 5560) (n=3440)	**<0.001***
BNP, pg/mL	545 (181, 1043) (n=118)	418 (148, 1117) (n=1267)	0.347
Hemoglobin, g/dL	13.0±1.8 (n=416)	13.4±1.8 (n=9851)	**<0.001***
Preimplantation ECG assessment			
Heart rate, bpm	80 (70, 90) (n=421)	70 (60, 80) (n=10301)	**<0.001***
Atrial rhythm			
Sinus	81.5% (344/422)	68.7% (7152/10414)[a]	**<0.001***
Atrial fibrillation	15.9% (67/422)	26.0% (2711/10414)[a]	
Atrial paced	0.5% (2/422)	2.9% (301/10414)[a]	
Other	2.1% (9/422)	2.4% (250/10414)	
Intrinsic QRS duration, ms	151±19 (n=398)	157±27 (n=9137)	**<0.001***
Intrinsic QRS duration <120 ms	3.5% (14/398)	7.6% (697/9137)[a]	
120≤ Intrinsic QRS duration <130 ms	6.5% (26/398)	5.2% (479/9137)	
130≤ Intrinsic QRS duration <150 ms	26.1% (104/398)	18.3% (1675/9137)[a]	
150≤ Intrinsic QRS duration <180 ms	56.8% (226/398)	46.6% (4260/9137)[a]	
Intrinsic QRS duration ≥180 ms	7.0% (28/398)	22.2% (2026/9137)[a]	
Pacemaker dependent	6.4% (27/422)	14.4% (1484/10330)	**<0.001***
Paced QRS duration, ms	169±39 (n=26)	181±31 (n=1430)	**0.041***
Paced QRS duration <130 ms	15.4% (4/26)	4.3% (62/1430)[a]	
130 ≤ Paced QRS duration <150 ms	19.2% (5/26)	6.7% (96/1430)[a]	
150 ≤ Paced QRS duration <180 ms	23.1% (6/26)	29.8% (426/1430)	
Paced QRS duration ≥180 ms	42.3% (11/26)	59.2% (846/1430)	
QRS morphology			
Normal	2.9% (12/421)	7.4% (767/10379)	**<0.001***
LBBB	79.1% (333/421)	72.5% (7528/10379)	**0.003***
RBBB	1.7% (7/421)	6.8% (703/10379)	**<0.001***
Indeterminate	14.0% (59/421)	10.1% (1053/10379)	**0.010***
Not available	2.6% (11/421)	3.4% (351/10379)	-
AV node ablation in patients with AF	26.9% (18/67)	30.4% (816/2683)	0.533
Performed	55.6% (10/18)	22.4% (183/816)[a]	
Planned	44.4% (8/18)	77.6% (633/816)[a]	

Data are presented as mean±standard deviation, median (interquartile range) or n (%). *Denotes statistical significance. [a]Indicates statistical significance for this row, calculated using the odds ratios including 95% confidence intervals.
AF - atrial fibrillation; AV - atrioventricular; BMI - body mass index; BNP - brain natriuretic peptide; ECG - electrocardiogram; LBBB - left bundle branch block; NYHA - New York Heart Association; RBBB - right bundle branch block

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Table 4. Preimplantation imaging assessment of survey participants

	Patients in Turkey (n=424)	Patients in other European centers (n=10,664)	*P*-value
Imaging used for CRT implantation			
Echocardiography	99.8% (421/422)	97.6% (10213/10467)	**0.004***
Cardiac MRI	1.2% (5/421)	10.2% (1058/10415)	**<0.001***
CT scan	0.5% (2/421)	1.5% (161/10405)	0.077
Scintigraphy	6.2% (26/421)	3.6% (371/10404)	**0.005***
Placement of scar evaluation-based LV lead	1.7% (7/422)	3.0% (314/10348)	0.103
Method used to determine LVEF			0.688
LV angiography	0.2% (1/422)	2.2% (232/10409)	**0.006***
Echocardiography	95.7% (404/422)	92.2% (9595/10409)	**0.007***
MRI	0.2% (1/422)	4.8% (495/10409)	**<0.001***
Scintigraphy	3.8% (16/422)	0.8% (87/10409)	**<0.001***
LVEF (by any method), %	25 (20, 30) (n=422)	30 (23, 34) (n=10383)	**<0.001***
LVEF (by any method) <25%	32.9% (139/422)	27.4% (2840/10383)[a]	
25≤ LVEF (by any method) ≤35%	64.0% (270/422)	59.3% (6156/10383)[a]	
LVEF (by any method) > 35%	3.1% (13/422)	13.4% (1387/10383)[a]	
Echocardiography data			
LVEF, %	25 (20, 30) (n=414)	30 (23, 34) (n=10132)	**<0.001***
LVEDD, mm	63.6±9.7 (n=361)	63.5±9.1 (n=8276)	0.449
Mitral regurgitation			
Mild	45.4% (176/388)	46.5% (4468/9612)	**<0.001***
Moderate	37.9% (147/388)	26.0% (2499/9612)[a]	
Severe	8.5% (33/388)	6.8% (657/9612)	
None	8.2% (32/388)	20.7% (1988/9612)[a]	

Data are presented as mean±standard deviation, median (interquartile range) or n (%). *Denotes statistical significance. [a]Indicates statistical significance for this row, calculated using the odds ratios including 95% confidence intervals.
CRT - cardiac resynchronization therapy; CT - computed tomography; LV - left ventricular; LVEDD - left ventricular end-diastolic diameter; LVEF - left ventricular ejection fraction; MRI - magnetic resonance imaging

placement (vs. 9.1%, OR: 1.37, 95% CI: 1.01–1.86). Main reason for unsuccessful LV lead placement was absence of suitable coronary vein (63.6 vs. 52%, OR: 1.62, 95% CI: 0.42–6.22). Nearly one-third of patients (30.5%) had multipolar LV lead implanted (vs. 58.1%, OR: 0.32, 95% CI: 0.26–0.39). Phrenic nerve stimulation was tested in fewer patients (70.3 vs. 91.3%, p<0.001). The LV position was evaluated by biplane X-ray projection in 75.3% of patients (vs. 88.7%, p<0.001). The distal tip of the LV lead pointed lateral on the left anterior oblique views in 69.6% (vs. 84.7%, p=0.046) and the middle of the cardiac silhouette was aimed in right anterior oblique views in 67.9% (vs. 71.3%, p=0.246) (Table 5).

Complications after any implantation attempt (includes all successful and unsuccessful attempts) among the survey participants are given in Table 6.

The periprocedural complication rate was 6.3% (vs. 5.5%, p=0.488). The most common complication was bleeding (40.7 vs. 16.4%, p=0.001), and prevalence of bleeding requiring intervention was similar (36.4 vs. 33.0%, OR: 1.16, 95% CI: 0.32–4.26). Pneumothorax (3.7 vs. 19.0%, p=0.045) and coronary sinus dissection (14.8 vs. 35.2%, p=0.029) were less commonly observed (Table 6).

Post-CRT implantation data

ECG characteristics and device programming after successful implantation among the survey participants are shown in Table 7.

Mean paced QRS duration was 123 ms (vs. 139 ms, p<0.001). More than two-thirds of patients (69.0%) had paced QRS duration of <130 ms (vs. 33.0%, OR: 4.51, 95% CI: 3.65–5.58). Median reduction in QRS duration was greater in the Turkish cohort (26 vs. 20 ms, p<0.001). More patients underwent atrioventricular (71.8 vs. 57.3%, p<0.001) and ventriculoventricular (75.1 vs. 55.6%, p<0.001) programming prior to discharge. Device-based software was commonly preferred to optimize programming (67.2 vs. 35.1%, p<0.001) (Table 7).

Postimplantation hospitalization characteristics

Postimplantation hospitalization characteristics are given in Table 8.

Table 5. Procedural details in survey participants with successful attempts for CRT implantation

	Number of successful implantations in Turkey (n=418)	Number of successful implantations in other European countries (n=10.380)	*P*-value
Type of device			
CRT-P	1.7% (7/418)	31.4% (3249/10351)[a]	**<0.001***
CRT-D	98.3% (411/418)	68.6% (7102/10351)[a]	
Operator			**0.014***
Electrophysiologist	71.8% (300/418)	77.2% (8002/10361)[a]	
HF physician	0.5% (2/418)	5.2% (539/10361)[a]	
Invasive cardiologist	27.8% (116/418)	11.7% (1214/10361)[a]	
Surgeon	0.0% (0/418)	4.5% (464/10361)	
Other	0.0% (0/418)	1.4% (142/10361)	
Location of procedure			**<0.001***
Cathlab	28.8% (120/417)	25.1% (2598/10341)	
Dedicated EP lab	53.0% (221/417)	29.8% (3079/10341)[a]	
Device implantation lab	18.0% (75/417)	34.1% (3526/10341)[a]	
Operating theater	0.2% (1/417)	10.5% (1083/10341)[a]	
Other	0.0% (0/417)	0.5% (55/10341)	
Duration, min	71 (52, 113) (n=408)	90 (66, 120) (n=10019)	**<0.001***
Fluoroscopy time, min	18 (9, 30) (n=408)	14 (8, 22) (n=9934)	**<0.001***
Prophylactic antibiotics	99.8% (417/418)	98.6% (10110/10254)	**0.048***
Test shock	1.9% (8/416)	4.9% (498/10230)	**0.006***
First implanted lead			
RV lead	93.3% (389/417)	83.1% (8427/10138)[a]	**<0.001***
LV lead	6.7% (28/417)	16.8% (1705/10138)[a]	
RV lead placement			
Apex	88.7% (354/399)	60.1% (5926/9854)[a]	**<0.001***
Septum	10.3% (41/399)	37.5% (3692/9854)[a]	
Right ventricular outflow tract	1.0% (4/399)	2.4% (236/9854)	
Successful LV lead placement	97.4% (407/418)	99.5% (10126/10176)	**<0.001***
- Lead placement epicardially	12.0% (49/407)	9.1% (918/10126)[a]	
Unsuccessful LV lead placement	2.6% (11/418)	0.5% (50/10176)	**<0.001***
Main reasons			0.642
Coronary sinus not identified	18.2% (2/11)	18.0% (9/50)	
Extracardiac simulation	0.0% (0/11)	0.0% (0/50)	
No suitable coronary vein	63.6% (7/11)	52.0% (26/50)	
Complication	0.0% (0/11)	8.0% (4/50)	
Other	18.2% (2/11)	22.0% (11/50)	
Patient referred to another center	0.0% (0/11)	10.2% (5/49)	0.268
LV lead type			
Unipolar	3.1% (13/417)	0.6% (64/10184)[a]	**<0.001***
Bipolar	66.4% (277/417)	41.3% (4201/10184)[a]	
Multipolar	30.5% (127/417)	58.1% (5919/10184)[a]	
Coronary venogram performed	90.2% (377/418)	91.6% (9259/10111)	**0.320**
Venogram performed with occlusion	27.7% (104/376)	47.9% (4382/9146)	**<0.001***
Dilation of coronary vein performed	8.1% (34/418)	2.1% (217/10120)	**<0.001***
Phrenic nerve stimulation tested	70.3% (294/418)	91.3% (9262/10150)	**<0.001***
LV lead position evaluation	93.4% (384/411)	96.6% (9559/9891)	**<0.001***
Biplane X-ray projection	75.3% (289/384)	88.7% (8482/9559)[a]	

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Table 5. Cont.

	Number of successful implantations in Turkey (n=418)	Number of successful implantations in other European countries (n=10.380)	*P*-value
Monoplane LAO	22.7% (87/384)	10.6% (1018/9559)[a]	
Monoplane RAO	2.1% (8/384)	0.6% (59/9559)[a]	
LAO site evaluation			
Anterior	10.0% (41/411)	4.1% (406/9889)[a]	**0.046***
Lateral	69.6% (286/411)	84.7% (8379/9889)[a]	
Posterior	20.4% (84/411)	11.2% (1104/9889)[a]	
RAO site evaluation			
Basal	18.0% (74/411)	14.7% (1431/9708)	0.246
Middle	67.9% (279/411)	71.3% (6921/9708)	
Apical	14.1% (58/411)	14.0% (1356/9708)	
LV position optimized	39.3% (164/417)	33.6% (3320/9890)	**0.015***
Electrical delay such as QLV interval	31.1% (51/164)	61.1% (2001/3277)[a]	
Paced QRS duration	62.8% (103/164)	60.3% (1973/3271)	
Other means	65.0% (106/163)	22.3% (729/3263)[a]	

Data are presented as median (interquartile range) or n (%). *Denotes statistical significance. [a]Indicates statistical significance for this row, calculated using the odds ratios including 95% confidence intervals.
CRT-D - cardiac resyncronization therapy defibrillator; CRT-P - cardiac resyncronization therapy pacemaker; EP - electrophysiology; HF - heart failure; LAO - left anterior oblique; LV - left ventricular; RAO - right anterior oblique; RV - right ventricular

Table 6. Complications after any implantation attempt (includes all successful and unsuccessful attempts) among the survey participants

	Number of attempts in Turkey (n=428)	Number of attempts in other European countries (n=10.787)	*P*-value
Periprocedural complication	6.3% (27/428)	5.5% (596/10787)	0.488
Death during the procedure	0.0% (0/27)	1.3% (8/596)	0.545
Bleeding	40.7% (11/27)	16.4% (98/596)	**0.001***
Requiring intervention	36.4% (4/11)	33.0% (32/97)	
Pocket hematoma	63.6% (7/11)	80.4% (78/97)	
Pneumothorax	3.7% (1/27)	19.0% (113/596)	**0.045***
Hemothorax	0.0% (0/27)	1.5% (9/596)	0.520
Coronary sinus dissection	14.8% (4/27)	35.2% (210/596)	**0.029***
Pericardial tamponade	7.4% (2/27)	4.0% (24/596)	0.390
Other	33.3% (9/27)	26.5% (158/596)	0.434

Data are presented as n (%). *Denotes statistical significance

The median hospital stay was 3 days (vs. 3 days, p=0.718). An adverse event was reported in 10.8% of patients (vs. 4.5%, p<0.001), and 0.5% patients died due to cardiovascular reasons during the index hospitalization (vs. 0.4%, p=0.819). The most common adverse event was the worsening renal functions (3.6 vs. 0.9%, p<0.001), and myocardial infarction (MI), infection, worsening HF, and arrhythmias were also more commonly observed in Turkish patients during hospitalization.

Discharge data

Follow-up was planned in 92.6% of patients (vs. 86.1%, p<0.001). Remote device monitoring was planned to be used in only 10.7% patients (vs. 30.6%, p<0.001).

Postimplantation therapy at the time of discharge is shown in Table 9.

HF medications at the time of discharge included loop diuretics (81.8%), beta-blockers (BBs) (95.9%), angiotensin-converting

Table 7. ECG characteristics and device programing after successful implantation among the survey participants

	Number of successful implantations in Turkey (n=418)	Number of successful implantations in other European countries (n=10.380)	*P*-value
Postimplant ECG			
Paced QRS duration, ms	123±16 (n=413)	139±24 (n=9663)	**<0.001***
Paced QRS duration <130 ms	69.0% (285/413)	33.0% (3192/9663)[α]	
130≤ Paced QRS duration <150 ms	21.8% (90/413)	35.3% (3408/9663)[α]	
150≤ Paced QRS duration <180 ms	9.0% (37/413)	25.7% (2484/9663)[α]	
Paced QRS duration ≥180 ms	0.2% (1/413)	6.0% (579/9663)[α]	
Paced-intrinsic QRS duration, ms	-26 (-41, -12) (n=390)	-20 (-40, 0) (n=8545)	**<0.001***
Device programing			
AV programing performed prior to discharge	71.8% (301/419)	57.3% (5831/10174)	**<0.001***
VV programing performed prior to discharge	75.1% (314/418)	55.6% (5648/10159)	**<0.001***
Device-based software optimization for	67.2% (281/418)	35.1% (3540/10082)	**<0.001***
AV or VV If yes, was it			
Automatic	17.4% (49/281)	66.2% (2327/3513)[α]	**<0.001***
Manual	82.6% (232/281)	33.8% (1186/3513)[α]	

Data are presented as mean ± standard deviation, median (interquartile range), or n (%). *Denotes statistical significance. [α]Indicates statistical significance for this row, calculated using the odds ratios including 95% confidence intervals.
AV - atrioventricular; ECG - electrocardiogram; VV - ventriculoventricular

Table 8. Postimplantation hospitalization characteristics

	Patients in Turkey (n=424)	Patients in other European centers (n=10.664)	*P*-value
Total length of hospital stay, day	3 (2, 7) (n=420)	3 (2, 7) (n=10346)	0.718
Adverse events	10.8% (46/424)	4.5% (482/10664)	**<0.001***
MI	0.5% (2/422)	0.1% (6/10394)	**0.002***
Stroke	0.0% (0/422)	0.1% (6/10394)	0.622
Infection	2.4% (10/422)	0.5% (50/10394)	**<0.001***
Worsening HF	1.7% (7/422)	0.7% (71/10394)	**0.020***
Worsening renal function	3.6% (15/422)	0.9% (89/10394)	**<0.001***
Arrhythmias	3.1% (13/422)	1.1% (115/10394)	**<0.001***
Other	1.2% (5/422)	2.0% (203/10394)	0.260
Complications that necessitated an intervention	3.1% (13/424)	4.1% (435/10664)	0.299
Phrenic nerve stimulation	0.5% (2/422)	1.2% (121/10408)	0.191
Lead dislocation or displacement	1.9% (8/422)	1.7% (180/10408)	0.798
RV	0.0% (0/7)	32.4% (55/170)	0.070
LV	100.0% (7/7)	50.6% (86/170)	**0.010***
Atrial	0.0% (0/7)	20.0% (34/170)	0.188
Lead malfunction	0.0% (0/422)	0.2% (23/10408)	0.334
RV		38.1% (8/21)	
LV		47.6% (10/21)	
Atrial		19.0% (4/21)	
Infection	0.5% (2/422)	0.2% (18/10408)	0.158
Other	0.5% (2/422)	1.0% (109/10408)	0.252
CV death	0.5% (2/421)	0.4% (43/10424)	0.819

Data are presented as median (interquartile range) or n (%). *Denotes statistical significance.
CV - cardiovascular; HF - heart failure; LV - left ventricular; MI - myocardial infarction; RV - right ventricular

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enzyme inhibitors (ACEi) or angiotensin II receptor blockers (ARBs) (89.7%), and mineralocorticoid receptor antagonists (MRAs) (77.2%). Overall, 30.1% of patients were anticoagulated, 53.2% with warfarin (Table 9).

Discussion

This study provides insights into the current clinical CRT implantation practice in Turkey for the first time in the literature. Through a "snapshot" survey, discrete information about the hospital facilities, annual cardiac interventional activities, and implanter profiles in the participating centers, as well as baseline characteristics of CRT implantation candidates in most aspects along with procedural details, postimplantation management during hospitalization, and follow-up plans are provided. In addition, comparison of the Turkish data with the rest of the European cohort demonstrates the variations in HF patients and their management in terms of CRT implantation. Turkey was among the top 10 countries that enrolled most of the patients for this survey, which enabled several statistical analyses to be conducted.

At the time of survey, most of the participating centers were university hospitals, same was the case with the other European countries. This may be explained that university hospitals function as tertiary referral hospitals and may be predisposed to research activities. Cardiac surgery on site was more prevalent in Turkey, and this is particularly important in cases when periprocedural complications necessitate urgent surgical interventions. A relatively high proportion of epicardial LV lead implantations is a reflection of the presence of surgery team. Although the number of catheterization laboratories was same, there were less dedicated electrophysiology laboratories per center in Turkey. We believe, with the introduction of official subspeciality training in cardiology, number of dedicated electrophysiology laboratories may increase in Turkey.

According to the baseline site questionnaire, annual CRT implantations in Turkey was less than other European countries because of the lower annual CRT-P implantation. Inappropriate shocks are avoided with CRT-P. Thus, selection of CRT-D over

Table 9. Postimplantation therapy at discharge

	Number of successful implantations in Turkey (n=417)	Number of successful implantations in other European countries (n=10.380)	*P*-value
Loop diuretic	81.8% (341/417)	81.0% (8280/10218)	0.705
ACEi/ARB	89.7% (373/416)	86.3% (8790/10187)	0.049
MRA	77.2% (319/413)	62.6% (6363/10160)	**<0.001***
Beta-blocker	95.9% (401/418)	88.7% (9071/10230)	**<0.001***
Ivabradine	14.6% (59/404)	5.3% (534/10139)	**<0.001***
Digoxin	18.1% (73/403)	10.1% (1027/10141)	**<0.001***
Calcium channel blocker	4.0% (16/401)	9.2% (930/10130)	**<0.001***
Amiodarone	13.4% (54/402)	17.5% (1771/10145)	**0.036***
Other antiarrhythmic agent	2.0% (8/401)	1.7% (173/10130)	0.664
Oral anticoagulant	30.1% (124/412)	47.3% (4804/10165)	**<0.001***
Warfarin	53.2% (66/124)	70.7% (3397/4804)	**<0.001***
Dabigatran	11.3% (14/124)	6.5% (313/4804)	**0.035***
Rivaroxaban	23.4% (29/124)	12.1% (582/4804)	**<0.001***
Apixaban	12.1% (15/124)	10.3% (494/4804)	0.512
Edoxaban	0.0% (0/124)	0.4% (18/4804)	0.495
Antiplatelet agent	63.0% (267/424)	42.9% (4579/10664)	**<0.001***
Aspirin	61.7% (245/397)	40.5% (4112/10150)	**<0.001***
Clopidogrel	14.1% (56/397)	12.3% (1248/10150)	0.282
Ticagrelor	0.3% (1/397)	1.3% (135/10150)	0.062
Prasugrel	0.5% (2/397)	0.3% (29/10150)	0.431
Dual and triple therapy			
DAPT	9.3% (37/397)	9.3% (944/10150)	0.990
Oral anticoagulation and P2Y12 inhibitor	3.4% (14/412)	4.2% (426/10208)	0.439
Triple therapy	2.4% (10/412)	2.0% (208/10209)	0.584

Data are presented as n (%). *Denotes statistical significance.
ACEi - angiotensin-converting enzyme inhibitor; ARB - angiotensin-II receptor blocker; DAPT - dual antiplatelet therapy; MRA - mineralocorticoid receptor antagonist

CRT-P should be based on a careful assessment to know if the patient really requires the "defibrillator" function of the device. Some patients match the CRT indications that are independent from the defibrillator requirement, such as patients who are anticipated to require frequent ventricular pacing (>40%) or patients with AF in whom rate control will result in near 100% ventricular pacing with CRT (11). The benefit of defibrillator therapy may be minimal or even obsolete if LVEF is expected to improve. Also, the importance of patient preferences (if properly informed) should not be underestimated. The decision on the type of the device should be made together with the CRT candidate, taking the unfavorable effects of inappropriate shocks on quality of life in HF patients into account (12). CRT-P has a lower cost, and this careful decision-making process may lead to improvements in health economics. This obviously is not a straightforward decision, since future CRT-P to CRT-D conversions are linked with rehospitalization, reoperation, and even pocket infections. Last but not least, the variations in CRT types (either CRT-P or CRT-D) with respect to supply by the manufacturers and reimbursement strategies across countries may play a role in physicians' decision. Data presented here reflect the approach of only the participating centers. Thus, CRT-P/D implantation rates and reasons of preferences should be thoroughly evaluated nationwide to figure out if the large gap really exists between CRT-P and CRT-D as observed in the snapshot survey.

In Turkey, CRT candidates were mostly younger than 65 years. There were fewer subjects aged ≥75 years. This may be explained with the conservative approach of patients, patients' relatives, and physicians in Turkey. Younger study cohort may have contributed to higher rates of CRT-D implantation. As for the etiology of HF in the cohort, about 51.4% patients were reported to have ischemic HF, 42.4% had MI, and 48.6% had prior revascularization. These findings suggest that optimal primary and secondary prevention of coronary atherosclerotic disease may result in lower HF, thus in CRT implantation rates.

It is not clear whether the ischemic/nonischemic etiology is defined in a similar way among physicians. Felker et al. (13) have reported that patients with single-vessel disease and no history of MI or revascularization should be classified as nonischemic for prognosis. Definitions of comorbidities, such as hypertension, AF, DM, chronic obstructive pulmonary disease (COPD), CKD, and anemia, were not provided to participating centers prior to initiation of the survey. Therefore, discrepancies may be present both within the same country and other European countries in reporting disease prevalence. In Turkey, the prevalence of comorbidities was found similar to those reported from snapshot survey of HF patients during October–November 2015 from 23 centers (8). In that snapshot, prevalence of hypertension, DM, COPD, and previous MI was reported to be 46%, 27.5%, 12.8%, and 45.2%, respectively (vs. 57.1, 31.8, 10.9, and 42.4%, respectively, in Turkish CRT Survey-II data). Anemia in HF patients, either in the form of absolute or functional iron deficiency, is another comorbidity that should be investigated and treated as suggested by recent guidelines (2). Although anemia was more common in the Turkish cohort, it is pleasing to see the mean hemoglobin value of 13 g/dL.

Most CRT candidates in Turkey were classified as NYHA class II. The number of patients who were in NYHA class III was less, prevalence of NYHA classes I and IV was similar. Patients presenting with NYHA class III–IV symptoms and signs may have become compensated following diuretic therapy and optimized guideline-directed therapy, so that they may have been assigned to NYHA I–II group prior to the implantation procedure. The questionnaire did not show time specification for some variables, which may create discrepancy both within the same country and other European countries. Although the ESC-HFA guidelines (2) do not provide recommendations for patients in NYHA functional class I, only the ACC/AHA/HRS guidelines (14) provide a class IIb recommendation, level of evidence (LOE): C, on condition that the patients have LBBB with a QRS ≥150 ms, HF caused by ischemia, and an LVEF ≤30% on guideline-directed medical therapy. Patients in whom the driving cause of CRT implantation was HF and an ICD or HF and a PPM indication with expected RV pacing dependence may explain class I–II patients in the cohort.

Turkish cohort had a lower BMI. The mean BMI was within the limit of being overweight. This may be due to the fact that more HF patients in other European countries were obese. Regarding higher heart rate prior to implantation observed in the Turkish cohort, the lack of time specification may have affected the observed data (e.g., ECG taken at the electrophysiology laboratory when the patient was stressed for the procedure or ECG taken at admission when the patient was decompensated). The survey does not provide any preimplantation guideline-directed HF medication details, therefore it is not possible to link preimplantation heart rate with beta-blockade adequacy.

QRS morphology, intrinsic QRS duration, and LVEF are among the essential determinants of CRT indications (11). Nearly 80% CRT candidates had LBBB and 3% had normal QRS morphology, both better than other European countries. RBBB at baseline ECG was also less prevalent in the Turkish cohort. More than half of the CRT candidates had an intrinsic QRS duration of ≥150 and <180 ms; 3.5% had <120 ms and nearly a quarter had ≥120 and<130 ms. ESC-EHRA guidelines (1) provide a class III recommendation, LOE: B, for a QRS duration <120 ms; whereas the ESC-HFA guidelines (2) provide a class III recommendation, LOE: A, for QRS duration <130 ms. ESC-HFA guidelines were recently introduced; this may be speculated to be a reason for inclusion of patients who had QRS duration <130 ms. In addition, some may have specific CRT indications, such as anticipated high ventricular pacing, which do not necessitate specific QRS duration criteria to be met. LVEF was evaluated by echocardiography in almost 96% cases. Nearly two-thirds had LVEF ≥25 and <35% and one-third had <25%. Scar evaluation-based LV lead placement was employed only in 1.7% patients. However, this is not currently recommended for routine clinical practice. These findings suggest that CRT implantation indications are correctly applied in the current practice in Turkey.

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Operators were mostly electrophysiologists. Electrophysiologists were found to be less in number in Turkey as compared to other European countries, and more invasive cardiologists were involved with CRT implantation. The term "HF physician" was not established in Turkey, due to lack of subspeciality training in cardiology. In terms of other procedural aspects, CRT implantation took a shorter duration of time (difference in mean duration: 20 min); however, fluoroscopy time was longer (difference in median time: 4 min). Factors such as physician experience and guidance through fluoroscopy may have shortened the duration of procedure. Indeed, taking into account that LV lead implantation success was lower in Turkey, one may have expected that the procedure would have lasted longer. Referral of patients to cardiovascular surgery units, reflected with the higher epicardial LV lead placement, may be the reason for the shorter procedure time. Reasons for unsuccessful LV lead placement were found to be unsuitable coronary sinus anatomy and unidentified coronary sinus in 63.6 and 18.2% of patients, respectively. Preimplantation coronary sinus angiographic imaging using computed tomography may prove useful for guiding the procedure. Shortage of equipment due to problems in reimbursement might have played a role in unsuccessful LV lead placement, attributed to "other" causes in 18.2% patients.

Routine defibrillation testing (DT) at the time of ICD implantation is a controversial topic, and several recommendations about the group of patients to undergo DT have been specified in a multinational Consensus Statement on Optimal ICD Programing and Testing (15). Its authors have stated that in the presence of appropriate sensing, pacing, and impedance values with fluoroscopically well-positioned RV leads in patients undergoing initial left pectoral transvenous ICD implantation, omitting DT may be reasonable (class IIa), and that DT may be considered in patients undergoing a right pectoral transvenous ICD implantation (class IIa) (15). Although test shock was performed less in Turkey, this does not pose a safety issue (16). More importantly, fluoroscopic evaluation for optimal LV lead assessment was performed less, and biplane X-ray projection was less preferred among them. LV lead at the lateral on the left anterior oblique projection was less noted, whereas LV lead in the middle on the right anterior oblique projection was similar with that of other European countries. Phrenic nerve stimulation was also less tested, which should definitely be routinized to prevent postimplantation complications. Less performance of test shock and phrenic nerve stimulation explain shorter procedure times in the Turkish cohort. For LV lead position optimization, mostly paced QRS duration was measured. Electrical delay measurement via QLV interval measurement was less preferred. These findings suggest that optimal implantation and LV lead placement techniques are underused in Turkey. However, these findings can impact on both reducing the risk of complications and increasing the efficiency of the CRT. Nevertheless, on the postimplantation ECG, it was found that absolute median reduction in QRS duration was greater in Turkish patients. Device programing prior to discharge was also more common.

Periprocedural complication rate was found similar in Turkey and other European countries. Bleeding was the most common periprocedural complication, mostly in the form of pocket hematoma. Pneumothorax was less encountered in the Turkish cohort. This may be related with accessing subclavian vein under fluoroscopy, which may also account for the prolonged fluoroscopy time in Turkey. Coronary sinus dissection was also less observed, which may be speculated to be associated with epicardial LV lead placement in unsuitable coronary sinus anatomies. During hospitalization for the implantation, the most common adverse event observed was worsening renal functions, which may be due to overdiuresis or contrast media exposure during implantation. Rate of complications that necessitated interventions was similar. LV lead dislocation/displacement was more common in the Turkish cohort, which may be because of dilatation in the coronary sinus or inappropriate techniques. Lack of or low supply of active fixation LV leads by the manufacturers may also play a role in LV lead displacement/dislocation.

Not all patients were prescribed with the guideline-directed medical therapy agents (BBs, ACEi/ARBs, and MRAs) at discharge. Although the prescription rate of BBs was close to 100%, lower rates observed in the others may be because of worsened renal functions during hospitalization, and they may be planned to be initiated at follow-up visits. Yet, prescription rates of BB and MRA s were higher in the Turkish cohort. Warfarin, being the most preferred oral anticoagulant, was less prescribed in Turkey compared to other European countries. Among novel oral anticoagulants, dabigatran and rivaroxaban had higher prescription rates in the Turkish cohort. Edoxaban was not reimbursed in Turkey at the time of survey. Use of antiplatelet agent in Turkey was apparently more frequent than expected (63.0%), taking into account that 48.6% had prior revascularization history. There has been an ongoing debate on the use of antiplatelet agents in the setting of primary prevention population. With insufficient data on full baseline characteristics in this cohort (particularly with regard to the history of atherosclerotic cerebrovascular disease), antiplatelet prescription rates in HF population should be assessed in further studies. Remote monitoring is less preferred for the follow-up of patients in Turkey. This has its own advantages of enabling a combination of assessment for clinical symptoms and signs with the recorded events at the time of device interrogation. On the other hand, remote monitoring may reduce emergency department and unplanned office visits. Even if not intended to replace standard follow-up office visit protocols, utilization of remote monitoring for specific conditions (such as patient being hospitalized in another facility, patient being unable to reach medical care, or patient being notified by an alert from the device) may be adopted.

Study limitations

There are several limitations of this study. First, this survey was undertaken in 16 centers from 6 cities in Turkey on

voluntary basis. Therefore, generalizability of the data to the whole country is low. Second, the degree of selection bias in the choice of enrolled patients cannot be assessed. Sites might have been less reluctant to report unsuccessful implants or cases with a poor outcome, complications, or adverse events. Last but not least, specific diagnostic definitions for comorbidities and time specifications for several assessments were lacking, and these might have led to variations between centers both at the national and international level. In some questions, the answer option "other" limited further classification of the data, since the participants were not able to specify the condition under the heading "other."

Conclusion

CRT Survey-II provides a valuable source of information on contemporary clinical practice with respect to CRT implantation in a large sample of ESC member states. This study provides the first observational data reflecting the current CRT practice in Turkey. Overall, this survey provides a comprehensive observational data that permit meaningful benchmarking between the highest recruiting countries and for assessing guideline adherence and healthcare resource utilization. It also provides valuable information on how physicians extrapolate existing data to clinical practice in Turkey and enables comparison with other ESC member countries. The data collected are sufficient to assist in educational initiatives and identifying appropriate directions for future research.

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