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Research Article

Lack of Knowledge of Cardiac Resynchronization Therapy and Implantable Cardioverter Defibrillator Management among Swedish Primary Health Care Physicians

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Abstract

Background: The aim of this observational cross-sectional study was to assess knowledge among primary care physicians with regard to heart failure treatment with cardiac resynchronization therapy (CRT) and an implantable cardioverter defibrillator (ICD).

Methods: An electronic questionnaire with knowledge-based questions in the field of CRT and ICD was developed. The questionnaire was distributed to 196 physicians working in primary care with a response rate of 35.2%.

Results: The mean total score was 7.5 out of 15. Respondents had highest accuracy (81.2%) when asked about pharmacological treatment for heart failure. However, 20.3% had never heard of CRT. Results were similar between specialists and residents in general medicine (7.1 and 8.0, respectively, p = 0.107) and between male and female respondents (7.6 and 7.4, respectively, p = 0.736). A subset of questions relating to CRT indications had a mean score of 1.9/5.

Conclusion: Physicians in primary care routinely treat patients with heart failure and demonstrate good knowledge of pharmacological therapy for this condition. However, one out of five respondents had not even heard of CRT or device-based therapy for heart failure, despite the fact that device therapy can confer morbidity and mortality benefits on appropriate heart failure patients. This demonstrates an important gap in knowledge among primary care specialists.

Keywords: *Cardiac Resynchronization Therapy; Heart Failure; Implantable Cardioverter Defibrillator; Physician Knowledge; Primary Care*

Abbreviations

CRT: Cardiac Resynchronization Therapy; EF: Ejection Fraction; ESC: European Society of Cardiology; ICD: Implantable Cardioverter Defibrillator; LA: Left Atrial; LBBB: Left Bundle Branch Block; NYHA: New York Heart Association; OPT: Optimal Pharmacological Therapy; RBBB: Right Bundle Branch Block; SD: Standard Deviation

Introduction

Some chronic heart failure patients exhibit systolic dyssynchrony, which is a complex and multifaceted condition leading to a cascade of events: if the atrioventricular interval is prolonged, this delays the systolic contraction, which, in turn, impedes diastolic filling [1].

This leads to an impaired interplay between atrial and left ventricular (LV) diastolic pressures, with mitral regurgitation and reduced contractility in the LV as a result [1]. Ventricular dyssynchrony is caused by inter- and intra-ventricular conduction delays and leads to asynchrony in the contraction of the LV walls, causing reduced stroke volume, impairing cardiac efficacy, and decreasing systolic blood pressure [1,2]. This is particularly prominent in left bundle branch block (LBBB) where the electric activity is delayed both within the LV and between the ventricles.

The established classification of function and severity of heart failure symptoms is the New York Heart Association (NYHA) classification. NYHA is divided in four groups, where class I has no symptoms and class IV has the most severe symptoms. With NYHA comes a recommendation for treatment and estimation of prognosis.

Cardiac resynchronization therapy (CRT) reduces cardiac dyssynchrony (atrioventricular, inter- and intra-ventricular dyssynchrony) by electrically stimulating the exterior of the LV just before, or simultaneously with, pacing inside the right ventricle. CRT has demonstrated benefit in certain heart failure patients; CRT reduces mortality and hospitalization, improves symptoms and health-related quality of life, and counteracts cardiac dyssynchrony [3-5].

Previously, CRT had been a treatment exclusively for patients with moderate to severe heart failure (NYHA III-IV), but later studies showed that patients with milder symptoms (NYHA II) also benefit from CRT [6-8].

CRT prevents the progression of heart failure in asymptomatic and mildly symptomatic patients (NYHA I-II) by improving LV function and LV dimensions [6]. CRT also reduces the risk of having a heart-failure-related incident and mortality (41% and 34%, respectively) [6-8].

The European Society of Cardiology (ESC) changed guidelines regarding CRT in 2010, with strong recommendations that CRT should be considered for patients with mild symptoms (NYHA II) with a widened QRS-complex > 150 ms [1].

Even though these guidelines were launched in 2010, there has not been a change in clinical practice and there remain broad regional differences in Sweden in terms of how many patients receive treatment with CRT [9-11]. According to data from two EuroHeart Failure surveys and hospital discharge data, it is estimated that annually about 400 patients/million population could be suitable candidates for CRT [1]. In Sweden, statistics show there were 160/million inhabitants who received *de novo* CRT devices in 2013 [10]. In Sweden in 2016, there were 66/million and 47/million inhabitants treated with CRT-D or CRT-P devices, respectively. Regional differences were large, in that they varied from 12-102/million inhabitants (CRT-P) and 45 - 147/million (CRT-D) [11].

The implantable cardioverter defibrillator (ICD), effectively terminates life-threatening arrhythmias by cardioversion (i.e. shock) or anti-tachycardia pacing. An ICD can be indicated as primary prevention therapy in patients with a reduced ejection fraction (EF), various cardiac disease states with specific risk factors that increase risk for sudden cardiac death. Heart failure patients may be indicated for an ICD if they have been treated with optimal pharmacological therapy (OPT) for at least three months and have a reasonable life expectancy of > 1 year [1]. Survivors of sudden cardiac death or a ventricular tachycardia with hemodynamic compromise, are indicated for ICD therapy as secondary prevention therapy. Because the guidelines have been expanded to include CRT and patients with milder forms of heart failure, it seems reasonable that many patients indicated for CRT/ICD treatment are treated in primary care and may have no contact with a cardiologist. Thus, it seems important that primary care physicians should have sufficient knowledge about CRT/ICD treatment for heart failure patients to be able to identify appropriate patients for referral to cardiologists. Therefore we conducted this study with the aim to assess level of knowledge of CRT/ICD management among primary care physicians.

Methods

Setting

This survey was distributed between 9 November 2017 and 22 January 2018, including four reminders. The questionnaire was developed by a cardiologist with expertise in the field of CRT/ICD and a residency in general medicine (Table 1). The questions were developed from the ESC guidelines [1]. The questionnaire was produced in an electronic form that was accessible by an external internet link that could be sent by email. The survey was designed so that respondents had to answer all of the questions to complete it, thereby reducing the risk of partial loss of data. Respondents had to state their age, sex, when they took their degree, and if they were specialists, residents, or interns. The following questions were knowledge based and measured familiarity with heart failure, CRT and ICD devices, and international guidelines. Fifteen of the questions were considered as especially relevant for measuring knowledge and represented the parts of total score where each respondent received 1 point for every correct answer.

Data collection

Email addresses of all primary care physicians in Gävleborg, Sweden were obtained from the unit head in all of the healthcare centers in the region (n = 43). The heads of the units gave their consent to distribute the questionnaire by email to their employees.

After collecting the email addresses there was a mass mailing to the physicians. Physicians who had no long-term employment at the health care center were excluded. There were 4 reminder mails sent during this period and during 2 local educational meetings for general medicine there were an additional reminder to answer the questionnaire.

Participation in the study was voluntary and all replied data were treated anonymously, which were distinctly described in the mail sent to the participants.

Statistics

The data from the questionnaire were imported from Excel 2010 (Microsoft Corporation, Redmond, WA) into SPSS version 22 (IBM, Armonk, NY). Descriptive data were expressed as frequencies and percentages. Mean values, including standard deviations (SD) were calculated and 25, 50, and 75 percentiles were described. Mean values were compared using t-test and chi-squared test for categorical data. A binomial test was used to compare whether the participants had encountered patients with CRT and ICD respectively.

Ethics

The questionnaire was solely directed to physicians and along with information that it was voluntary. The questionnaire was distributed after approval of each unit head and data were treated as confidential.

Results

The questionnaires were emailed to 196 physicians (107 males and 89 females) currently working in primary health care, of whom 69 (35.2%) responded. The response rate was similar between males (34.6%) and females (36.0%), (p = 0.84). Among the 69 participants, 53.6% (n = 37) were males. Mean age was 47.1 years (SD 12.7); males 51.5 (SD 12.5) and females 42.0 (SD 11.2), respectively. The majority were specialists in general medicine (56.5%) or residents in general medicine (33.3%) with 2.9% saying they were specialists in another field of medicine, and 4.3% were interns. This was a fairly experienced respondent group with a mean interval since graduating from medical school of 19.1 years (SD 12.9). The distribution of the answers is depicted in table 1.

Question/statement	Options of response	Distrubution of response
Have you heard of CRT (cardiac resynchronization therapy)?	Yes	55 (79.7%)
	No	14 (20.3%)
Have you heard of ICD (implantable cardioverter defibrillator)?	Yes	69 (100%)
	No	0
Have you met a patient with CRT?	Yes	31 (44.9%)
	No	38 (55.1%)
Have you met a patient with ICD?	Yes	64 (92.8%)
	No	5 (7.2%)
Have you referred a patient for CRT?	Yes	10 (14.5%)
	No	59 (85.5%)
Have you referred a patient for ICD?	Yes	17 (24.6%)
	No	52 (75.4%)
A 65-year old woman with heart failure is restricted because of dyspnea when walking up the stairs of two levels but can walk several kilometers on plane ground. Which NYHA function class does she belong to?	NYHA 0	0
	NYHA I	31 (44.9%)
	NYHA II	36 (52.2%)
	NYHA III	2 (2.9%)
	NYHA IV	0
Which function class(es) constitutes the primary indication for CRT?	NYHA I + II	0
	NYHA II	0
	NYHA II + III	12 (17.4%)
	NYHA III + IV	47 (68.1%)
	NYHA IV	10 (14.5%)
Which function class(es) constitutes the primary indication for ICD in primary prevention?	NYHA I	0
	NYHA I +II	3 (4.3%)
	NYHA II + III	21 (30.4%)
	NYHA III + IV	39 (56.5%)
	NYHA IV	6 (8.7%)
What is optimal pharmacological treatment for heart failure at NYHA III, besides ACE-I/ARB?	Loop diuretics	1 (1.4%)
	Loop diuretics and calcium antagonist	2 (2.9%)
	Mineralocorticoid antagonist	1 (1.4%)
	Beta-blocker and mineralocorticoid antagonist	56 (81.2%)
	Beta-blocker, mineralocorticoid antagonist and calcium antagonist	9 (13.0%)
Which QRS-morphology and QRS-width has the strongest indication for CRT?	**Left bundle branch block (LBBB) ≥ 150 ms**	19 (27.5%)
	Right bundle branch block (RBBB) ≥ 150 ms	3 (4.3%)
	Left bundle branch block (LBBB) 120-150 ms	14 (20.3%)
	Right bundle branch block (RBBB) 120-150 ms	1 (1.4%)
	Bifascicular block (right bundle branch block + left anterior fascicular block) 100-120 ms	18 (26.1%)

What is the upper limit for ejection fraction (EF) to be able to motivate CRT?	55%	0
	45%	0
	35%	12 (17.4%)
	25%	47 (68.1%)
	15%	10 (14.5%)
Where is the CRT-electrodes placed in patients in sinus rhythm?	In the right atrium	5 (7.2%)
	In the left ventricle	9 (13.0%)
	In the right ventricle	7 (10.1%)
	Outside the left ventricle and inside the right ventricle	17 (24.6%)
	Inside the right atrium, inside the right ventricle and outside the left ventricle	31 (44.9%)
Which of the following alternatives is a requirement for receiving a ICD	**Life expectancy > 1 year**	46 (66.7%)
	Pathological exercise test	0
	Reduced left ventricle function	13 (18.8%)
	Ischemic heart disease	4 (5.8%)
	Non-ischemic dilated cardiomyopathy	6 (8.7%)
How long should a patient have optimal pharmacological heart failure treatment prior to CRT?	12 months	8 (11.6%)
	9 months	1 (1.4%)
	6 months	42 (60.9%)
	3 months	15 (21.7%)
	1 month	3 (4.3%)
Permanent atrial fibrillation is an exclusion criterion for CRT	Yes	15 (21.7%)
	No	54 (78.3%)
There is an ICD-function in CRT-P	True	23 (33.3%)
	False	46 (66.7%)
There is an ICD-function in CRT-D	**True**	59 (85.5%)
	False	10 (14.5%)
The treatment for ventricular arrhythmias (shock and anti-tachycardia pacing) is deactivated when a magnet is placed upon the ICD	**True**	48 (69.6%)
	False	21 (30.4%)
The pacemaker function is deactivated when a magnet is placed upon the ICD	True	40 (58.0%)
	False	29 (42.0%)
The pacemaker function is deactivated when a magnet is placed upon the CRT	True	38 (55.1%)
	False	31 (44.9%)

Table 1: *Survey questions with response distribution.*

Bold style is the correct answer.

All of the respondents had heard about ICDs (100%) and most also knew about CRT (79.7%) Significantly fewer respondents had encountered a patient with CRT compared to ICD (44.9% vs. 92.8%, $p < 0.001$). Only a few respondents had ever referred a patient specifically for evaluation for an ICD (n = 17; 24.6%) or CRT (n = 10; 14.5%) device.

CRT knowledge

Only 12 (17.4%) answered correctly which main NYHA function classes are indicated for CRT (NYHA II and III); the majority answered NYHA III and IV (68.1%) or NYHA IV (14.5%). Similar results occurred in terms of which EF scores were an indication for CRT, with only 17.4% correctly identifying the upper limit for EF to qualify for CRT (n = 12). Most respondents thought the EF scores had to be lower than the guidelines state to qualify for CRT.

There were also a wide range of different answers regarding what ECG configuration and QRS width constitutes the strongest indication for CRT. A total of 19 respondents (27.5%) answered correctly (LBBB and QRS ≥ 150 ms), while 14 (20.3%) answered LBBB with QRS width 120-150 ms and 18 (26.1%) answered bifascicular block with a QRS duration of 100 - 120 ms (both incorrect answers).

The majority of the participants thought that a patient should be treated with OPT for a longer period of time than stated in the guidelines; 51 (73.9%) answered six months or longer on OPT, whereas 15 (21.7%) gave the correct answer of three months.

There were some heterogeneous answers regarding lead placement when a patient with sinus rhythm receives a CRT device; 31 of the participants (44.9%) answered correctly (right atrium, right ventricle and outside of the left ventricle), but 7.2% answered right atrium only, 13.0% and 10.1% stated left or right ventricle only, respectively, and 24.6% said outside of the left ventricle and inside the right ventricle only.

In total, 6 out 15 of the knowledge-based questions was statements which the respondent had to answer if it was correct or not and that implicates a situation where the respondent had a 50% chance of guessing the right answer.

The majority, 78.3% (n = 54) answered correctly that permanent atrial fibrillation is not an exclusion criterion for CRT. When asked which CRT device is a combination of CRT and ICD, 85.5% (n = 59) answered correctly that CRT-D is a CRT device that has an ICD-function as well. However 33.3% (n = 23) incorrectly replied that a CRT-P device also has an ICD-function.

ICD knowledge

Twenty-one respondents (30.4%) correctly answered which NYHA function classes constitute indication for ICD in primary prevention (NYHA II and III). As for the questions regarding CRT and NYHA function class, a majority thought that an ICD was a treatment for the most frail patients: 39 (56.5%) responded NYHA III + IV and 6 (8.7%) answered NYHA IV.

Most respondents (n = 48, 69.6%) knew that the shock and anti-tachycardia pacing function is deactivated when a magnet is placed over the ICD device. However, the majority (58.0%) answered incorrectly that the pacemaker function is also deactivated with magnet placement. When asked about the health requirements regarding ICD-treatment, 66.7% of the respondents replied correctly that to an ICD candidate had to have a life expectancy of > 1 year.

Total score

The mean score for the whole group was 7.54 (SD 2.2) out of 15. Residents in general medicine had a mean total score of 8.0 and specialists in general medicine had a mean total score of 7.1 but the difference between the two groups did not reach statistical significance, $p = 0.107$. There were no significant differences in scores between male and female physicians (7.6 vs 7.4; $p = 0.736$).

Five questions were picked out that were considered of particular importance in measuring knowledge about the indications for CRT: NYHA function class, QRS morphology and QRS duration, EF scores, OPT for heart failure, and duration of OPT prior to CRT implantation. The maximum score for this subset of questions was 5 and respondents had a mean score of 1.89 (SD 0.96) for this subset.

There was no linear correlation between years since graduation from medical school and total score.

Discussion

Despite its known benefits, CRT is under-utilized in indicated patients. In a retrospective study based on the Swedish Heart Failure Registry (n = 12,807 patients), 69% of heart failure were not indicated for CRT and 24% who were indicated for CRT did not use it [12]. The main variables associated with non-use of CRT were: recent heart failure (< 6 months), non-cardiology planned follow-up, residence in a small town without a university center, female, no atrial fibrillation, living alone, mental health disorder, smoking, and not taking heart failure pharmacological therapy. These findings are not limited to Europe. In a study of 72,008 heart failure patients in America, it was found that only 26.3% of eligible patients had CRT devices with women and black patients less likely to get CRT devices compared to men and white patients, respectively [13].

Our study explored the role of primary healthcare in terms of identifying appropriate candidates for CRT and making the proper referrals. Over 20% of respondents in primary care had never heard of CRT and the mean score of overall knowledge of CRT was 7.54/15, which is inadequate. In particular, respondents were unclear about CRT indications (NYHA class, QRS morphology on the ECG, ejection fraction scores, pharmacological therapy for heart failure and duration of optimal pharmacological therapy prior to CRT). Based on the fact that respondents generally had good knowledge of drug therapy for heart failure, it seems as if primary care physicians were more comfortable with pharmacological than device-based therapies for this populations. Two misconceptions emerged in this study, namely that only more severe (NHYA III-IV) patients should be considered for CRT and that a prolonged period of optimal pharmacological therapy was required prior to trying CRT. Better knowledge of CRT indications is needed among primary care physicians.

Approximately 2% of the adult population suffers from heart failure [1] which means that a physician in a normal-sized healthcare center treating about 2,000 patients should statistically see about 40 patients with heart failure, of whom possibly about 5% to 10% might be indicated for CRT [3]. This means that each primary care physician routinely sees two to four patients a year who likely could benefit from CRT. A lack of knowledge of CRT may have serious consequences by not providing these patients with the information and referrals they might need to obtain potentially life-enhancing or even life-saving device-based benefits.

CRT confers morbidity and mortality benefits to a subset of heart failure patients. Thus, a greater knowledge of CRT and its indications would benefit patients. In particular, the idea that CRT may be indicated sooner rather than later in heart failure patients (NYHA Class II, shorter period of optimal pharmacological therapy) is an important but largely unknown concept. A survey of CRT conducted by the European Society of Cardiology (n = 11,008 patients) in 42 ESC member countries found that about a third (32%) of heart failure patients with CRT are ≥ 75 years of age, 28% got a CRT devices as an upgrade from a pacemaker or ICD, 30% had CRT-P rather than CRT-D, and 26% were in atrial fibrillation at the time of CRT device implant [14]. This suggests that younger, fitter heart failure patients are not routinely treated with CRT. Of course, in today's cost-conscious healthcare system, the consideration emerges that expanding device therapy to "less sick" patients could have adverse financial ramifications. However, the REVERSE (Resynchronization reverses Remodeling in Systolic Left Ventricular Dysfunction) study showed that device costs were more than offset by the probabilistic estimates of quality-adjusted life year for NYHA Class II patients [15].

Better knowledge of CRT/ICD and treatment guidelines are also needed even among hospital specialists (cardiologists, internal medicine specialists, specialists in geriatrics) as a recent survey found that only 41% had adequate knowledge about the potential role of CRT/ICD in heart failure care [16].

With the increasing number of patients with CRT and ICD one can expect that physicians in primary care will be required to take care of these patients in a greater extent than previous and that basic knowledge of CRT and ICD will therefore be of higher importance. It is preferable that doctors in primary care who is responsible for palliative care and geriatric care have the familiarity of deactivating an ICD to prevent unnecessary and painful shock close to death [16,17] and more knowledge about ICD would lead to a greater willingness to discuss these matters with patients and next of kin [18]. In this study 69.6% answered correctly that when a magnet is placed upon the ICD the shock function is switched off.

Limitations of the Study

Our study has certain limitations. It was a survey with the inherent limitations of a questionnaire-based study and subsequent intermediate response rate. It remains unknown if knowledge among those who did not answer the questionnaire would have even lower score. One question was accidentally omitted from the survey in the first mailing but this error was corrected quickly.

Conclusions

Survey scores of 7.5/15 indicate a lack of fundamental knowledge of CRT and ICD among primary care physicians. A subset of questions relating to CRT indications had a mean score of 1.9/5. CRT/ICD represents an important life-enhancing and life-saving therapy for heart failure patients. ESC guidelines published in 2010 aims to advance the care of heart failure patients, but a better understanding of these guidelines and their translation into clinical practice are needed.

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Author Contributions

- Erik Gidlöf: Writing the article, data acquisition, data analysis, and interpretation.
- Jo Ann LeQuang: Writing the article, data analysis, and critical revision.
- Joseph V Pergolizzi: Data analysis and interpretation, and critical revision.
- Peter Magnusson: Idea, design, data analysis and interpretation, critical revision, and project management.

Conflicts of Interest

The authors declare no conflicts of interest.

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