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Patient's knowledge of daily activities, need for information and quality of life after cardiac electronic device implantation

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Abstract: Introduction: Cardiac implantable electronic devices (CIED) such as pacemakers or cardioverter defibrillators prevent dangerous heart arrhythmias and conduction abnormalities. Post-intervention education is crucial in the patient recovery process and aims to avoid both dangerous behavior and unnecessary restraints in daily living.
Objective: The evaluation of knowledge of daily activities' safety among patients with CIEDs and an analysis of the relationship between the state of knowledge and perceived post-intervention quality of life.
Materials and Methods: The study group included 100 patients (57% men) with CIEDs, recruited in the University Hospital in Kraków. Data on the patients' knowledge about permissible daily activities, medical procedures and perceived quality of life was collected using a dedicated questionnaire, which comprised 57 simple and multiple-choice questions.
Results: The analyzed group included patients aged 28 to 97 years (mean age 73). Among them, 26% either have not received or have not read the information booklet. Two-thirds of them either need more information about their device (51%) or do not possess essential knowledge (15%). Patients raised concerns about performing daily activities such as: car-driving (38%), using seat belts (14%), bathing (15%), returning to work (51%) or climbing stairs (16%). They reported anxiety when using computers (39%), mobile phones (51%), microwaves (73%) and even electric toothbrushes (51%). It has been observed that patients with a greater general understanding of the pacemaker and post-implantation restraints had a higher quality of life on average.
Conclusions: Patients with CIEDs restrain themselves excessively in daily living. There is a strong need to provide them with knowledge of their medical condition, concomitant capabilities, and limitations to undergo a fully successful rehabilitation. Comprehensive and easily comprehensible recommendations may play a key role in improving patients' quality of life.

Keywords: CIED, post-intervention education, patient knowledge, quality of life, pacemaker.

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Introduction

Cardiac implantable electronic devices (CIEDs) have been widely used for many years in the treatment of rhythm and conduction defects as well as in primary and secondary prevention of sudden cardiac death due to malignant paroxysmal arrhythmias, and in the case of devices used in cardiac resynchronization therapy as a treatment of heart failure. The number of pacemaker implantations in Europe according to European Society of Cardiology (ESC) registries has been constantly increasing, reaching recently over 500,000 new implantations per year, with 30,000 of them performed in Poland [1, 2]. Similarly, the life expectancy of patients with an implanted pacemaker is still increasing, already approaching that of the general population [3].

The device implantation is often a life-saving procedure for its recipient. The reasons for the device implantation vary depending on the underlying heart pathology. Indications for a pacemaker include sinus node dysfunction and acquired atrioventricular blocks; cardioverter defibrillators are used in ventricular tachyarrhythmia treatments and in sudden cardiac death prevention, whereas cardiac resynchronization therapy may be needed by some patients with heart failure and wide QRS complex.

CIEDs may allow recipients to regain their normal activity level despite an ongoing heart disease. Following device implantation, patients are informed by hospital staff about their medical status and associated limitations; they are also given a booklet made by the CIED producer with information on the device function along with recovery period guidelines [4–6]. Lack of adequate post-intervention education may result in hazardous behavior endangering the implanted device. Alternatively, it may lead to incomplete recovery, related to restraint in daily activities and excessive concerns about one's health status.

For these reasons, we chose the aims of our study to be an evaluation of knowledge of daily activities' safety among patients with CIEDs, a measurement of its impact on their day-to-day activity and an analysis of the relationship between the state of knowledge and perceived post-intervention quality of life.

Materials and Methods

Study design

A voluntary, paper-form survey comprised 57 simple- and multiple-choice questions and was conducted between the period of February to July 2020. Patients who met our inclusion criteria were outpatient clinic or ward patients with CIEDs, treated in the Departments of Cardiology, University Medical Hospital, Kraków, Poland. The exclusion criteria were lack of consent, cognitive impairment or being in hospital di-

rectly after first device implantation. Patients were invited to take part in the study and were informed that the answers are anonymous.

The study was approved by the Bioethics Committee of the Jagiellonian University in Krakow.

Survey structure

The survey consisted of six sections. The first part collected demographic data: age and sex, marital status, level of education, occupation, average household net monthly income and place of residence.

The next section consisted of questions associated with the implanted device. Patients were first asked about the implantation date, whether they normally carry their CIED identification card with them, and whether they had it at the time of the survey. Then, they assessed their overall knowledge about the device and evaluated the quality of post-intervention education received from the practitioner. The question whether the patients received and read the CIED booklet was raised, and other information sources were recorded. Additionally, respondents were asked if CIED implantation allows discontinuing heart medication treatment, whether it protects from myocardial infarctions and whether it influences one's blood pressure ("Yes"/"No"/"I don't know").

The third part concerned the patient's quality of life following the procedure. The assessment of possible changes in their life quality ("Improvement"/"No change"/"Deterioration") and daily activity level was made, compared to the time before the device implantation.

In the fourth section, patients were asked about the safety of daily activities. Respondents had to answer whether having an implanted device allows them to perform numerous activities (returning to professional work, driving a car, traveling in a car, engaging in sexual intercourse, climbing stairs, carrying light/heavy shopping bags etc.).

Then, a question was asked about the safety of various household and work-related devices. Patients had to answer if they could safely use mobile phones, computers, television, cookers, welders etc., move through airport security gates or fix car engines ("Yes/"No"/"Caution should be taken").

The last part related to safety of certain medical procedures. Respondents assessed whether CIED devices allow them to undergo basic dental works, to have an X-ray, an ultrasound test, a computer tomography, magnetic resonance imaging, an elective external cardioversion, and a massage.

Statistical Analysis

Statistica 13.3 software (StatSoft, Statistica 13, Tulsa, OK, USA) was used for data management and statistical analyses.

Continuous data were expressed as mean ± standard deviation (SD) and categorical data was expressed as number and percent. Analysis of categorical data was performed using the chi-squared ($\chi 2$) test or Kruskal–Wallis test. Generalized linear model was used to analyze the influence of covariates on the patients' reported daily activity and self-perceived quality of life. The significance level was set to 0.05. If not otherwise specified, the number equals percentage (as study group comprised 100 patients).

Population

The final study sample included 100 participants, the majority of whom were men (57%). The mean age was 73.6 years (SD = 12.94 years) and their mean device utility time equaled 77 months (SD = 65 months).

Two-thirds of respondents (67%) were retired at the time of the study. Almost two thirds (63%) lived with relatives at home. Average net monthly income per person equaled 1500 PLN (366 USD) or less in 46% of respondents. Nearly half of the investigated patients lived in the city. Details on the population characteristics are presented in Table 1.

Table 1. Demographic data of the patients with cardiac implantable electronic devices.

Demographic characteristics	**n = 100**
Age (years) (mean ± SD)	73.62 ± 12.94
28–65	17
66–75	35
76–85	32
86–94	16
Sex (M/F)	57/43
Education	
Elementary school	12
High school	41
Technical college	19

Table 1. cont.

Demographic characteristics	n = 100
University	28
Occupation	
Manual work	15
Intellectual work	8
Retired	67
Disability pension	9
Unemployed	1
Marital status	
Married/living with someone	63
Divorced/living alone	31
Single	6
Household monthly income per person (1 USD = 4.10 PLN)	
Less than 1000 PLN	8
1000–1500 PLN	38
2000–2500 PLN	33
2500–3000 PLN	12
3000–4000 PLN	7
More than 4000 PLN	2
Place of residence	
Village	35
Town less than 5,000 residents	2
5,000–50,000 residents	16
50,000–200,000 residents	2
City over 200,000 residents	45
Device utility time	2 months – 26.08 years
Mean ± SD	77 months ± 65 months

Results

Self-assessment of knowledge

At the time of the survey, 73% of respondents had their device ID with themselves at the time of the visit. When asked about the time following implantation, more than nine out of ten patients (93%) recalled receiving information on their device from medical staff and 87% of them were satisfied with its quality. Among all respondents, 26% either have not received or received but have not read the information booklet.

Fifty-seven percent of patients did not search for additional information elsewhere, while the internet was the most mentioned source for those who did (59%), followed by medical staff (16%) and family (12%). However, 51% of patients declared the need for more information despite moderate knowledge, whereas 16% described their knowledge as poor. Ninety-three percent acknowledged their need for heart medication, but 56% thought to be protected against myocardial infarction by their heart device. When asked whether CIEDs influence blood pressure, 43% of patients did not know the answer. The responses for the questions concerning patient knowledge on CIEDs are presented in Table 2.

Table 2. Patients' knowledge about their own CIED devices.

Did the patient receive the information booklet?	n = 100	
Yes	85	
No	15	
Did the patient read it?	n = 85 (%)	
Yes	74 (87)	
No	11 (13)	
	Yes (n)	No (n)
Do you always carry your CIED card?	70	30
Do you have your CIED card today?	73	27
Have you received information about the device from your doctor?	93	7
Was the received information enough to ensure correct behavior?	87	13
Have you searched for information and recommendations for patients with CIED on your own? And if so, where?	43	57

Table 2. cont.

Internet		26 (59%)	
Medical staff		7 (16%)	
Family		5 (12%)	
TV		4 (9%)	
Other		2 (4%)	
How would you assess your knowledge about the device?			
Poor (I do not have essential knowledge)		16	
Moderate (I would like to know more)		51	
Extensive (My knowledge is sufficient)		33	
Do you think that implantable heart devices protect against heart attacks?			
Yes		56	
No		12	
I don't know		32	
Do you need to take heart medications after receiving CIED?			
Yes		93	
No		4	
I don't know		3	
Does implantable cardiac device influence blood pressure?			
Yes		37	
No		20	
I don't know		43	

Quality of life and activity level

Overall, 71% of CIED patients declared post-intervention improvement in quality of life (Table 3). We noted that patients with declared extensive knowledge more often (81.8%) than those with moderate or poor knowledge (65.7%) observed improvement in quality of life, but this difference was not statistically significant.

Table 3. Quality of life following CIED implantation.

Quality of life after CIED implantation	All patients	Group with declared extensive knowledge	Group with declared poor or moderate knowledge
	n = 100	n = 33 (%)	n = 67 (%)
Improved	71	27 (81.8)	44 (65.7)
Not changed	24	4 (12.1)	20 (29.9)
Worsened	5	2 (6.1)	3 (4.5)
p value		0.148*	

* $\chi 2$ test with p value for the comparison of improvement in quality of life between groups with declared extensive knowledge and with declared poor or moderate knowledge.

Respondents also had to answer whether they perceived a change in everyday activity level following the procedure. They mainly (45%) reported no such change, however almost a quarter of patients (23%) declared deterioration of activity level following the procedure. The highest percentage of the post-procedural deterioration of daily activity was observed in younger participants (27% in the 1st age quartile vs 16.6% in the 4th quartile), although this difference did not reach statistical significance ($\chi 2 = 0.77$; $p = 0.38$). Table 4 presents bivariate distribution of daily activity and age quartiles.

Table 4. Daily activity following CIED implantation.

Daily activity	All patients		Q1 (28–67 years)	Q2 (68–74 years)	Q3 (75–82 years)	Q4 (83–94 years)
	n		n (%)	n (%)	n (%)	n (%)
Improved	32		7 (26.9)	11 (42.3)	7 (29.2)	7 (29.2)
Not changed	45		12 (46.1)	9 (34.6)	11 (45.8)	13 (54.2)
Worsened	23		7 (27.0)	6 (23.1)	6 (25.0)	4 (16.6)
p value					0.78**	

** Kruskal–Walis test (H = 1.0830) with p-value for the comparison of daily activity level between age-quartiles.

In the GLM, none of the analyzed demographic variables (age, gender, marital status, education, income, place of residency) was significant in regression analyses and prediction of post-procedural quality of life and activity level.

Safety of common activities and devices

Based on this analysis, it was discovered that many patients have anxiety about performing common daily activities as seen in Table 5. The majority stated concerns about doing sports with high risk of injury (76%), carrying heavy shopping bags (73%), hanging curtains (63%), grabbing upper handles in the bus (53%), returning to work (51%), and physical activity (50%).

Table 5. Safety of common activities performed by CIED patients.

Can patients with CIEDs.....?	Yes (n)	No (n)	I don't know (n)
Carry light shopping bags	87	3	10
Travel	86	3	11
Use seatbelts	86	7	7
Bath or swim	85	2	13
Climb stairs	84	0	16
Bend over	69	6	25
Drive	62	7	31
Sleep on the side	60	3	37
Return to their sexual life	55	17	28
Do physical activity	50	12	38
Return to work	49	11	40
Grab upper handles in the bus	47	10	43
Hang curtains	37	7	56
Carry heavy shopping bags	27	1	72
Do sports with high risk of injury	24	15	61

When it comes to electrical or gasoline devices, respondents felt anxiety towards most of the listed objects, including welders (90%), gasoline chain saws (79%), airport security gates (76%), cookers (73%), induction stoves (69%), electric toothbrushes (51%) and mobile phones (51%). All the responses are presented in Table 6.

Better knowledge was associated with safety of medical procedures (Table 7). Eighty-six percent, 82% and 86% of patients respectively declared as safe basic dental works, X-rays, and ultrasound tests. About half of respondents (52%) knew that they were not supposed to undergo MRI. One quarter (25%) did not know if a CT scan could be performed following a pacemaker implantation (Table 7).

Table 6. Safety of various household and work-related devices used by CIED patients.

Is it safe to use….?	Yes (n)	With caution (n)	No (n)
TV	88	11	1
Phone	79	15	6
Hairdryer or electric shaver	68	16	16
Oven	65	17	18
Computer	61	24	15
Smartphone	49	43	8
Electric toothbrush	49	19	32
Shopping gate	44	37	19
Gasoline lawn mower	39	27	34
Electric lawn mower	39	19	42
Fixing car engine	32	25	43
Induction stove	31	33	36
Cooker	27	36	37
Airport gates	24	32	44
Gasoline chain saw	21	30	49
Welder	10	27	63

Table 7. Safety of medical procedures performed on CIED patients.

Is it safe to have … done?	Yes (n)	No (n)	I don't know (n)
Basic dental work	86	5	9
X-ray	82	2	16
Ultrasonography	86	3	11
Computer tomography	61	14	25
Magnetic resonance imaging	12	52	36
Cardioversion	23	14	63
Massage	63	20	17

Discussion

Knowledge of CIED recipient guidelines

Only 33% of patients are satisfied with their knowledge about cardiac implantable electronic devices, which reveals the underlying need for more information. These findings are yet more disturbing than those from a large, multicenter survey conducted by European Heart Rhythm Association (EHRA), which found that 56% of patients were in need of more support concerning their CIED knowledge [7].

What the EHRA study did not demonstrate was the lack of actual knowledge on post-implantation patient guidelines among the respondents, which, in our study, is well-reflected in anxiety towards numerous harmless activities expressed in the questionnaire. In one of the few publications focused on the perception of daily activities among pacemaker patients, Aqeel *et al.* concluded that misconceptions are often the reason for unsuccessful recovery [8]. Physical restrictions imposed by patients themselves stemmed from perceiving permissible activities as unsafe. Although this study was conducted on a much less educated population in Pakistan (41% respondents were illiterate), surprisingly, some of the answers were similar or even slightly better than among our patients — e.g., declared safety of traveling in a car (91.4% vs. 86% in our study), driving a car (63.4% vs. 62%) or sleeping on the side of pacemaker (69.9% vs. 60%). Despite a general good understanding of daily activities' safety, patients in our study may also unnecessary restrict themselves in important areas of life, whether it be sexual intercourse (considered safe only by 55%), using computers (61%) or mobile phones (49%).

Bearing in mind that 13% of respondents were not satisfied by the doctor's instructions following implantation and 26% have not read the CIED information booklet, a greater importance should be given to early post-intervention education. The study performed by Yildiz *et al.* highlighted the importance of a constructed patient education intervention in the patient's rehabilitation process [9]. Patients assigned to the special educational group responded better to questions about daily activities' safety (e.g., work, sports, driving and sexual activity) than patients who did not receive the educational interview, even though the latter had been living with CIED for a much longer time.

While it is true that pacemaker patients may return to a relatively normal life soon after the procedures, some precautions should be taken to minimize the risk of complications. Multiple ESC recommendations have advised against intense physical activity among patients with cardioverter-defibrillators or pacemakers [10–12]. Another risk comes from certain household-, work- and healthcare-related objects which may hinder CIED activity through electromagnetic interference (EMI) [13, 14]. Thus, lack of sufficient post-intervention education may result in hazardous behavior which

endangers the implanted device function. However, our study demonstrated that patients are aware of the risks related to excessive physical activity and EMI brought about by electrical devices, often restricting themselves more than is necessary.

Respondents presented good knowledge about medical procedures — most of them correctly classified as safe standard dental works, X-rays, and ultrasound tests, while questioning the safety of magnetic resonance imaging (52% declared it shouldn't be done on CIED patients). Therefore, they proved to be better informed than the population evaluated by Aqeel *et al.*, where 86% patients did not know if MRI was safe for them.

A very high proportion (93%) of correct responses concerning the need for maintaining heart medication following CIED implantation is a satisfying finding, especially in view of the frequent coexistence between hypertension, heart failure and coronary heart disease — need for hypotensive medication, anticoagulation etc. [15, 16]. What is more alarming, though, is the patients' poor awareness of myocardial infarction origins — as many as 56% declared being protected against this disease owing to their CIED. This misconception might cause inaction in the event of angina symptoms and may even lead to life-threatening situations.

Quality of life and activity level

The question of quality of life and specific concerns related to the device were more broadly investigated in the multicenter EHRA study. Unsurprisingly, their results were consistent with our findings — 71% percent of the respondents in the EHRA study reported improvement in life quality following implantation, while it was impaired in only 5%. When asked about problems caused by the device, almost one quarter of patients declared they had difficulties regarding either diagnostic procedures (12%), daily activities (7%) or their professional life (4%). As our study showed, misconceptions around CIEDs are present in our population and may have a direct influence on a patient's perceived quality of life, hence the importance of a comprehensive discussion and education in patients with a newly implanted device is paramount.

To get a clearer image of CIED patients' recovery, we chose as well to ask patients about their post-implantation activity levels.

There is no doubt that alongside heart disease, patients' comorbidities may also lower their physical fitness and we should not always expect a full recovery; nevertheless, the importance of post-intervention education should not be disregarded in the rehabilitation process. We found that younger patients are more often endangered with deterioration of day-to-day activities following implantation. One possible explanation is that younger patients tend to lead more active lifestyles, thus feel more restricted by their diagnosis and heart device implantation than older patients; however, it could also stem from deficiency in knowledge on CIED patient guidelines.

Limitations

One of the limitations of our study was a relatively small group of analyzed CIED recipients, partly caused by limited access to patients during the COVID-19 pandemic. We did not take into account the influence that concomitant diseases may have on patients' answers, nor did we use a standardized health-related quality of life (HRQoL) questionnaire. Finally, in our study, we did not subdivide the group into the types of CIED device implanted (pacemaker, cardioverter-defibrillator, etc.) which might also influence the recovery pattern between different groups.

Conclusions

Post-intervention education is the essential part of a fully successful rehabilitation process in patients with cardiac implantable devices. Providing patients with a well-structured and easily comprehensible recommendation following CIED implantation is crucial in restoring activity levels to baseline values post-procedure.

Post-intervention education should be especially stressed among patients under 65, who feel more handicapped by the device than older patients. Obtaining knowledge on the permissibility of daily activities may play a key role to avoid unnecessary limitations and ultimately help improve the quality of life. Further research on post-intervention education and its impact on perceived quality of life among CIED patients is still needed.

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Conflict of interest

None declared.

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