Daily behaviors regarding using smartphones in patients with high-voltage cardiac implantable electronic devices

Maciej Dyrbuś, Mariusz Gąsior, Mateusz Tajstra

3rd Department of Cardiology, School of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland

Correspondence to:
Maciej Dyrbuś, MD,
3rd Department of Cardiology,
School of Medical Sciences
in Zabrze,
Medical University of Silesia,
Skłodowskiej-Curie 9,
41–800 Zabrze, Poland,
phone: +48 32 373 38 60,
e-mail: mdyrbus@op.pl

DOI: 10.33963/KP.a2022.0041

Received:
January 13, 2022

Accepted:
February 9, 2022

Early publication date:
February 9, 2022

INTRODUCTION

The growth of the connectivity market in the 21st century, along with an increasing demand for new, more advanced appliances, has led to the situation when a vast majority of citizens have multiple "smart" devices. It is estimated that nowadays more than six billion people use smartphones [1]. The results of the European Heart Rhythm Association survey indicate that more than 80 000 implantable cardioverter-defibrillators (ICDs) and 50 000 cardiac resynchronization therapy (CRT) devices are implanted each year in patients with heart failure (HF) in Europe [2]. Therefore, the number of patients who have both an implantable device and a smartphone increases each year.

Already in the 1990s, evidence demonstrating interference of mobile phones with ICDs has grown, and in recent years more cases of significant malfunctions, including deactivation of life-saving therapies in patients with ICDs, due to the proximity of a smartphone have been reported [3–8]. Although the incidence of smartphone-induced interferences remains uncertain, it is important to assess that probability based not only on benchmark tests but also on the patients' perspective including the daily habits of smartphone users. Therefore, we undertook this analysis to examine the patients' behaviors regarding their use of smartphones.

METHODS

One hundred fourteen consecutive patients with an ICD or cardiac resynchronization therapy device (CRT-D) implanted according to the guideline-directed indications, who attended the device follow-up in our institution's department between the July 5, 2021 and August 15, 2021 were asked to participate in the study. Two patients declined participation. Among patients who agreed, a questionnaire consisting of 17 questions has been distributed. The first 11 questions concerned patients' daily behaviors were answered by patients while the remaining 6 about their demographics and device characteristics were filled by the nurse. Full details of the questionnaire, both in Polish and in the English translation, can be found in the Supplementary material.

The approval of the ethics committee and patient informed consent were not required for this study.

Statistical analysis

The categorical variables were presented as counts and percentages. The normality of distribution of continuous variables was examined with the Shapiro-Wilk test and, as all variables were distributed non-normally, they were reported as median (interquartile range [IQR]). STATISTICA 10 (StatSoft Inc., Tulsa, OK, US) was used for the calculations.

RESULTS AND DISCUSSION

Of 114 patients who answered the questionnaire, 77 (68.8%) had a smartphone. The median age of patients having a smartphone was 63 years, and women constituted 24.7% of all patients. The median time from implantation was 2.6 years.

More than three-quarters of patients (76.6%) had a smartphone for more than three years, and the most common locations to carry a smartphone were either handbags on the right hand (25.9% of the overall population)

Table 1. Characteristics of the population of patients with a smartphone and a high-voltage device

Characteristics of patients having a smartphone		Value
Age, years, median (IQR)		63 (58–71)
Male sex, n (%)		58 (75.3)
Type of device, n (%)	ICD-VR	25 (32.5)
	ICD-DR	20 (26.0)
	CRT-D	32 (41.6)
Pacing dependency, n (%)		5 (6.5)
Prevention of sudden cardiac death (primary; secondary), n (%)		72 (93.5); 5 (6.5)
Time from implantation, years, median (IQR)		2.6 (1.3–5.7)
Time since purchasing the smartphone, n (%)	More than 3 years	59 (76.6)
	1–3 years	13 (16.9)
	Less than 1 year	5 (6.5)
Most common location to carry the smartphone, n (%)	Handbag on the left hand	7 (9.1)
	Handbag on the right hand	20 (25.9)
	Trousers pocket	38 (49.4)
	Jacket pocket on the left	5 (6.5)
	Jacket pocket on the right	9 (11.7)
	Other	6 (7.8)
Most common location to hold the smartphone while talking, n (%)	Left ear	21 (27.3)
	Right ear	53 (68.8)
	Patient using loudspeaker	12 (15.6)
Average hours a day spent on talking on the smartphone, n (%)	For more than 3 hours	1 (1.3)
	For 1–3 hours	16 (20.8)
	For less than 1 hour	52 (67.5)
	Almost none	8 (10.4)
Mobile phone turned on during the night, n (%)	Yes, next to the bed	35 (45.4)
	Yes, although far from the bed	33 (42.9)
	No	9 (11.7)
Experience of interference ever experienced by the patient, n (%)	Yes, several times	2 (2.6)
	Yes, once	1 (1.3)
	No, never	74 (96.1)
Change in the most common location to carry the smartphone after device implantation, n (%)	None	52/76 (68.4)
	Yes, in total	24/76 (31.6)
	Yes, in the jacket pocket on the right	9/24 (37.5)
	Yes, in the trousers pocket	4/24 (16.6)
Change in the most common location to hold the smartphone while talking after device implantation, n (%)	None	58 (75.3)
	Yes, in total	19 (24.7)
	Yes, to the left ear	2/19 (10.5)
	Yes, to the right ear	13/19 (68.4)
	Yes, the patient now using a loudspeaker	3/19 (15.8)
Change in the average time spent on using the smartphone, n (%)	None	51 (67.1)
	Yes, more	22 (28.6)
	Yes, less	4 (5.2)
Knowledge on the interference due to proximity of the smartphone and a device, n (%)	Yes, since implantation	54 (70.1)
	Yes, long after implantation	9 (11.7)
	None	14 (18.2)

Abbreviations: CRT-D, cardiac resynchronization therapy; ICD-DR, dual-chamber implantable cardioverter-defibrillator; ICD-VR, single-chamber implantable cardioverter-defibrillator

or a trouser pocket (49.4%). The most common location used to hold a smartphone while talking was the right ear (68.8%) followed by the left ear (27.3%). Most patients used the phone for talking for less than an hour a day (67.5%) while 20.8% of patients used it for 1–3 hours a day. Three patients (3.9%) ever experienced interference with their device functioning associated with using the smartphone. Of those, two experienced multiple incidents, while one reported a single incident.

After implantation, almost one in three patients (31.6%) reported a change in the most common location used to carry a smartphone, with the most frequent location then being a jacket pocket on the right side of the chest. Similarly, almost one in four patients after implantation (24.7%) modified the most common location to hold their smartphones while talking, most frequently to the right ear. However, it should be noted that two patients changed the preferred location to the left ear. Finally, almost 20%

of patients having a smartphone did not know about the possibility of interference between the smartphone held too close to the device, while the further 11.7% had not obtained such information at the time of implantation, but later.

Our analysis is the first report demonstrating the present habits of patients with cardiac implantable devices and smartphones. The population of patients has been restricted solely to patients with an ICD or a CRT-D due to two factors. First, the prior reports regarding interferences of modern smartphones with implantable devices indicate inhibition of life-saving interventions in patients with high-voltage devices. Second, due to the high risk of all-cause and sudden arrhythmic death, it is those patients who are at the highest risk in case of device malfunction [9].

Our results indicate that almost 30% of all surveyed patients did not know of the possibility of interference between a smartphone and a high-voltage device at the time of implantation. With constantly increasing numbers of people having smartphones, the number of patients who are possibly prone to such interference will increase over time. Moreover, approximately 30% of patients hold their phones close to the left ear, contrary to the guidelines of ICD manufacturers, who advise against placing the smartphone closer than 15 cm from the implanted device and holding it close to the left ear [10, 11].

Although three patients reported interference with device functioning associated with using the smartphone, such percentage could significantly change over time, as the more advanced smartphones with quick charging capability and long battery longevity are being introduced into the market. Increasingly popular Apple iPhone MagSafe, which unlike conventional charging methods utilizes a wireless charging system, has been reported to inhibit high-voltage therapies of ICDs due to magnets embedded in the structure of new iPhones [4]. These findings were recently supported by the demonstration, both *in vivo* and *ex vivo,* that the placement of an iPhone 12 Pro Max over the device might induce clinically relevant magnet interference [5]. Similar observations were made about other "smart" devices, including headphones; however, the most compelling evidence has been growing regarding smartphones [4–8]. Therefore, identification of patients' habits and perspectives — along with similar studies in different areas — concerning the use of smartphones should be considered pivotal in order to implement strategies to allow patients to obtain benefit from both a life-saving cardiac device, and use all advantages offered by present smartphones [12]. In that context, our study is the first to demonstrate the possible gaps in patient knowledge requiring educational efforts to minimize the risk of potentially life-threatening interferences, especially in pacing-dependent patients or in those with a high probability of malignant arrhythmias, who might get the largest benefit from a properly functioning ICD or CRT-D.

Limitations

First, the small sample size should limit the generalization of the results into broader populations. Moreover, there may be differences regarding the percentage of the population possessing smartphones, as well as in the type of those smartphones. Furthermore, no specifications of the smartphones were registered; however, such an approach was adopted to reduce the complexity of the survey for often elderly patients, who could have been unaware of such information. Finally, no information has been gathered regarding the specification of the implantable devices in the analyzed population (apart from the type of the device) or details of interference reported by the patients. That is because the primary purpose of the study was not to examine this issue but rather to define the behavioral patterns of patients with high-voltage devices using smartphones. Therefore, no data from the implantable devices were extracted regarding the parameters of the devices or details of possible interference events reported by patients.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

Conflict of interest: None declared.

REFERENCES

1. Number of smartphone users from 2016 to 2021 (in billions). Available online: www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/ (Access: January 13, 2022).
2. Raatikainen MJ, Arnar DO, Zeppenfeld K, et al. Statistics on the use of cardiac electronic devices and electrophysiological procedures in the European Society of Cardiology countries: 2014 report from the European Heart Rhythm Association. Europace. 2015; 17 Suppl 1: i1–75, doi: 10.1093/europace/euu300, indexed in Pubmed: 25616426.
3. Hayes DL, Wang PJ, Reynolds DW, et al. Interference with cardiac pacemakers by cellular telephones. N Engl J Med. 1997; 336(21): 1473–1479, doi: 10.1056/NEJM199705223362101, indexed in Pubmed: 9154765.
4. Greenberg JC, Altawil MR, Singh G. Letter to the Editor-Lifesaving therapy inhibition by phones containing magnets. Heart Rhythm. 2021; 18(6): 1040–1041, doi: 10.1016/j.hrthm.2020.12.032, indexed in Pubmed: 33418126.
5. Nadeem F, Nunez Garcia A, Thach Tran C, et al. Magnetic Interference on Cardiac Implantable Electronic Devices From Apple iPhone MagSafe Technology. J Am Heart Assoc. 2021; 10(12): e020818, doi: 10.1161/JAHA.121.020818, indexed in Pubmed: 34074132.
6. Lee S, Fu K, Kohno T, et al. Clinically significant magnetic interference of implanted cardiac devices by portable headphones. Heart Rhythm. 2009; 6(10): 1432–1436, doi: 10.1016/j.hrthm.2009.07.003, indexed in Pubmed: 19968922.
7. Seidman SJ, Guag J, Beard B, et al. Static magnetic field measurements of smart phones and watches and applicability to triggering magnet modes in implantable pacemakers and implantable cardioverter-de-

fibrillators. Heart Rhythm. 2021; 18(10): 1741–1744, doi: 10.1016/j.hrthm.2021.06.1203, indexed in Pubmed: 34600610.
8. Asher EB, Panda N, Tran CT, et al. Smart wearable device accessories may interfere with implantable cardiac devices. HeartRhythm Case Rep. 2021; 7(3): 167–169, doi: 10.1016/j.hrcr.2020.12.002, indexed in Pubmed: 33786313.
9. Wasiak M, Tajstra M, Pyka Ł, et al. Long-term clinical outcomes after placement of an implantable cardioverter-defibrillator: does the etiology of heart failure matter? Kardiol Pol. 2020; 78(4): 318–324, doi: 10.33963/KP.15242, indexed in Pubmed: 32200617.
10. Guide of Boston Scientific on the use of devices with electromagnetic capabilities in patients with implantable devices. Available online:www.bostonscientific.com/content/dam/lifebeat-online/en/documents/BSC_Electromagnetic_Compatibility_Guide.pdf (Access: January 13, 2022).
11. Guide of Biotronik on the use of electromagnetic devices in patients with implantable devices. Available online:https://biotronik.cdn.mediamid.com/cdn_bio_doc/bio23016/8207/bio23016.pdf (Access: January 13, 2022).
12. Maciąg A, Mitkowski P, Mazurek M, et al. Patient perspective and safety of remote monitoring of implantable cardioverter-defibrillators in the Polish Nationwide Multicenter Registry: the Medtronic CareLink network evaluation. Kardiol Pol. 2020; 78(11): 1115–1121, doi: 10.33963/KP.15556, indexed in Pubmed: 32794684.