FOLIA CARDIOLOGICA

PISMO SEKCJI POLSKIEGO TOWARZYSTWA KARDIOLOGICZNEGO: CHORÓB SERCA U KOBIET, ECHOKARDIOGRAFII, ELEKTROKARDIOLOGII NIEINWAZYJNEJ I TELEMEDYCYNY, KARDIOLOGII DZIECIĘCEJ, KARDIOLOGII EKSPERYMENTALNEJ, INTERWENCJI SERCOWO-NACZYNIOWYCH, NIEWYDOLNOŚCI SERCA, REHABILITACJI KARDIOLOGICZNEJ I FIZJOLOGII WYSIŁKU, INTENSYWNEJ TERAPII KARDIOLOGICZNEJ I RESUSCYTACJI, RYTMU SERCA, WAD ZASTAWKOWYCH SERCA, FARMAKOTERAPII SERCOWO-NACZYNIOWEJ

no. **1**/vol. **17**/**2022**

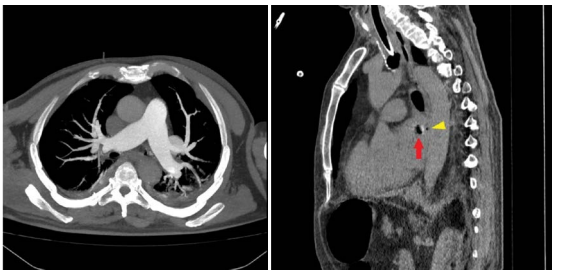
ISSN 2353–7752
e-ISSN 2353–7760

Folia Cardiologica 2022, vol. 17, no. 1, pages 1–72

ORIGINAL ARTICLES

REWIEV ARTICLES

CASE REPORTS



VIA MEDICA

www.journals.viamedica.pl/folia_cardiologica

FOLIA CARDIOLOGICA

„Folia Cardiologica" jest oficjalnym pismem Sekcji Polskiego Towarzystwa Kardiologicznego: Chorób Serca u Kobiet, Echokardiografii, Elektrokardiologii Nieinwazyjnej i Telemedycyny, Kardiologii Dziecięcej, Kardiologii Eksperymentalnej, Interwencji Sercowo-Naczyniowych, Niewydolności Serca, Rehabilitacji Kardiologicznej i Fizjologii Wysiłku, Intensywnej Terapii Kardiologicznej i Resuscytacji, Rytmu Serca, Wad Zastawkowych Serca, Farmakoterapii Sercowo-Naczyniowej

Folia Cardiologica, ISSN 2353–7752 (pod wcześniejszym tytułem *Folia Cardiologica Excerpta*, ISSN 1896–2475) jest czasopismem wydawanym 6 razy w roku przez wydawnictwo VM Media sp. z o.o. VM Group sp.k., ul. Świętokrzyska 73, 80–180 Gdańsk, tel. 58 320 94 94, faks 58 320 94 60, www.journals.viamedica.pl/folia_cardiologica

Adres Redakcji: I Klinika Kardiologii i Elektroterapii, Świętokrzyskie Centrum Kardiologii, Uniwersytet Jana Kochanowskiego, ul. Grunwaldzka 45 25–736 Kielce, tel. 41 36 71 510, faks 41 36 71 396

Czasopismo (pod wcześniejszym tytułem *Folia Cardiologica Excerpta*) jest indeksowane w bazach *CrossRef,* DOAJ (*Directory of Open Access Journals*), *EBSCO, Główna Biblioteka Lekarska, Google Scholar, Index Copernicus* (97,96 pkt.), Ministerstwa Edukacji i Nauki (2021 r., 40 pkt.), Polskiej Bibliografii Naukowej, i *Ulrich's Periodicals Directory*.

Zasady edycji i informacje dla autorów: wszelkie informacje dotyczące zakresu tematycznego pisma, zasad deponowania prac, przebiegu procesu recenzji i publikacji tekstów zamieszczono na stronie internetowej: www.journals.viamedica.pl/folia_cardiologica

FOLIA CARDIOLOGICA

2022, vol. 17, no. 1

Table of Contents/Spis treści

ORIGINAL ARTICLES/PRACE ORYGINALNE

REWIEV ARTICLES/PRACE POGLĄDOWE

CASE REPORTS/PRACE KAZUISTYCZNE

Folia Cardiologica 2022
vol. 17, no. 1, pages 1–10
DOI: 10.5603/FC.2022.0003

ISSN 2353–7752
e-ISSN 2353–7760

Daily sunshine hours as determinant of 25-hydroxyvitamin D concentration among diabetic cardiac patients who experienced myocardial infarction hospitalized due to acute coronary syndrome: a cross-sectional study

Dzienne nasłonecznie jako determinant stężenia 25-hydroksywitaminy D u pacjentów z cukrzycą i chorobami serca po hospitalizacji z powodu zawału serca z powodu ostrego zespołu wieńcowego — badanie przekrojowe

Ewelina A. Dziedzic[1], Jakub S. Gąsior[2], Paweł Płudowski[3], William B. Grant[4], Tomasz Saniewski[5], Marek Dąbrowski[6]

[1]Medical Faculty, Lazarski University in Warsaw, Warsaw, Poland
[2]Department of Pediatric Cardiology and General Pediatrics, Medical University of Warsaw, Warsaw, Poland
[3]Department of Biochemistry, Radioimmunology and Experimental Medicine, The Children's Memorial Health Institute, Warsaw, Poland
[4]Sunlight, Nutrition and Health Research Center, San Francisco, CA, Uniteda States of America
[5]Department of Internal Medicine, "Praski" Hospital, Warsaw, Poland
[6]Department of Cardiology, Bielanski Hospital, Warsaw, Poland

Abstract

Introduction. Vitamin D deficiency is a worldwide problem with a variety of health consequences. Vitamin D may reduce the risk of heart failure, however, evidence of the impact of vitamin D treatment on maintenance of cardiovascular health (i.e., preventing cardiovascular diseases) is conflicting due to lack of support from clinical trials. The reason for the failure of clinical trials to confirm an effect of vitamin D supplementation could be at least threefold: 1) too little vitamin D given to the participants or 2) lack of inclusion of only severely vitamin D-deficient populations or 3) study duration. The aim of this study was to characterize a group of cardiac patients who presented the lowest concentrations of 25-hydroxyvitamin D [25(OH)D].

Material and methods. Results of 92 diabetic cardiac patients aged between 41 and 89 years who experienced myocardial infarction, with significant coronary arteries changes, hospitalized due to acute coronary syndrome living in Warsaw were analyzed.

Results. Patients presented median 25(OH)D concentration value of 11 ng/mL (range: 4–28 ng/mL). The only significant determinant of 25(OH)D concentration was the date of examination, with higher concentrations in summer than in winter.

Conclusions. Vitamin D treatment in Polish cardiac patients aimed at reaching the optimal level of 30 ng/mL (75 nmol/L) seems to be necessary and implemented as soon as possible.

Key words: vitamin D, vitamin D deficiency, cardiovascular disease

Folia Cardiologica 2022; 17, 1: 1–10

Address for correspondence: Ewelina A. Dziedzic MD, PhD, Wydział Lekarski, Uczelnia Łazarskiego, ul. Świeradowska 43, 02–662 Warszawa, Poland, e-mail: ewelinadziedzic82@gmail.com

Introduction

Cardiovascular diseases (CVDs) are expected to be the main cause of mortality in most developing nations by 2020 [1]. More than ninety million American adults have at least one type of CVD, and more than forty percent of this population is projected to have some form of CVD by 2030 [2]. In Poland, CVDs are still one of the most common causes of death despite significant advancements in treatment [3]. Previously conducted clinical trials like e.g. POLSCREEN [4], POLKARD [5] and WOBASZ [6] illustrated the social significance of the problem.

Vitamin D plays an important role in the cardiovascular system by regulating blood pressure [7] and modulating vascular tone [8], facilitating stabilization of endothelial and smooth muscle cells through vitamin D receptors in the blood vessels and the heart [9–11]. The scientific debate on the association between 25-hydroxyvitamin D [25(OH)D] concentration and risk of CVD is ongoing. In recent years, an increasing number of studies has been published suggesting associations between vitamin D deficiency and increased risk of heart failure, adverse cardiac events, and cardiovascular-related deaths in various populations [12–16]. Based on Hill's criteria for causality in a biological system [17], it was approved that evidence supports confirms a causal association between serum 25(OH)D concentrations and increased risk for CVD for all criteria except experiment (i.e., vitamin D supplementation clinical trials) [18]. In contrast, it was also pointed out that data on the impact of vitamin D on cardiovascular health is conflicting [19] and that the link between vitamin D deficiency and cardiovascular disease may be an epiphenomenon [20]. As well as at present it is pointed out that the protective effect of vitamin D concerns only a specific range of its serum concentration and it suggests the negative impact of not only too low but also very high concentrations of 25(OH)D, which have been shown to increase cardiovascular risk [21]. Such U-shaped 25(OH)D relationships are suspect since participants are seldom questioned about when they began to supplement with vitamin D [22].

Therefore, it is essential to evaluate whether vitamin D supplementation (or vitamin D status correction) may play a role in the prevention of heart diseases and to defined groups of patients who benefited mostly from vitamin D supplementation as the greatest beneficial effects are observable in subjects with the lowest 25(OH)D concentration [9, 19, 23–25].

Recently, no significant association between the vitamin D status and severity of coronary atherosclerosis (expressed by the number of vessels with significant stenosis) was reported in numerous heterogeneous population of Polish cardiac patients with hypertension, diabetes, and/or hyperlipidemia [26]. A supplementary independent analysis showed that a group of cardiac patients with diabetes, hyperlipidemia, significant coronary arteries stenosis, hospitalized due to acute coronary syndrome (ACS), who experienced a previous myocardial infarction (MI) was identified as a group of patients with the lowest values of 25(OH)D concentration [27].

The primary aim of this study was to find determinants of the vitamin D status in patients with identified (in previous studies) low values of 25(OH)D concentration taking into account clinical factors. The secondary aim was to clinically characterize groups of cardiac patients in relation to vitamin D status.

Material and methods

Details of the study population (exclusion criteria) and measurements [diabetes diagnosis, ACS diagnosis, interview questionnaire, body mass index (BMI), concentration of total cholesterol (TC) and/or triglycerides (TG), systolic and diastolic blood pressure, coronary angiography and total 25(OH)D in participant serum and plasma] were presented elsewhere [26, 27]. The study was approved by the University Bioethical Committee (KB/124/2014) and followed the rules and principles of the Helsinki Declaration.

Population

This cross-sectional study comprises data of Polish patients referred for diagnostic catheter angiography in an evaluation for coronary artery disease to the cardiology department in 2016. The inclusion criteria were as follows: diagnosis of type 2 diabetes mellitus (T2DM), diagnosis of ACS, presence of previous MI, and significant changes in one, two, or three coronary vessels.

Institute of Meteorology and Water Management, National Research Institute from Warsaw, Poland provided detailed results on daily sunshine hours from the region of Warsaw. Thus, only data of Warsaw citizens were included in the final statistical analysis.

Examinations

Fasting blood samples were collected from the antecubital vein into the clot activator tubes. The serum concentration of 25(OH)D was determined with the "DiaSorin LIAISON® 25 OH Vitamin D TOTAL Assay" (DiaSorin, Stillwater, MN, USA) by a chemiluminescent immunoassay; range of detection 4–150 ng/mL, precision 5.0% cardiovascular, accuracy standard deviation 1.2% [28]. 25(OH)D concentrations were measured in ng/mL (1 ng/mL is equivalent to 2.5 nmol/L [29, 30]). Vitamin D External Quality Assessment Scheme (DEQAS) assessed the reliability of 25(OH)D and 1.25(OH)2D assays. The vitamin D status was classified according to the Endocrine Society clinical practice guidelines for vitamin D deficiency: severe

deficiency (concentration of 25(OH)D < 10 ng/mL), moderate deficiency (≥ 10 to < 20 ng/mL), mild deficiency (≥ 20 to < 30 ng/mL), and optimal (≥ 30 ng/mL) [31].

Data for the mean daily sunshine hours were obtained from the Institute of Meteorology and Water Management, National Research Institute, Warsaw, Poland. Patients' examinations were performed throughout the whole year on what may influence their 25(OH)D value. National Health and Nutrition Examination Survey (NHANES) reported the season of blood draw as winter months (November to April) and summer months (May to October) [32]. Vitamin D can only be produced when there is ultraviolet B (UVB), which occurs only during 6 months in Poland [33].

Statistics

The Wilk-Shapiro test was used for evaluating the data distribution. Log transformation (ln) was used if the data were not normally distributed. The potential determinants for the magnitude of the 25(OH)D concentration were investigated using multiple regression analysis. A backwards, stepwise regression analysis was used to identify significant predictors of the 25(OH)D concentration from among independent variables in patients examined during winter and summer months separately. Mann–Whitney U test was used to compare the results between the two groups. Pearson's chi-squared test or Fisher's exact test were used to determine differences between prevalence in selected groups. The statistical analysis was carried out with STATISTICA 12.5 software (significance level of 5% — p value < 0.05). GraphPad Prism 5.0 (GraphPad Software Inc., La Jolla, CA, USA) was used to create Figure 1.

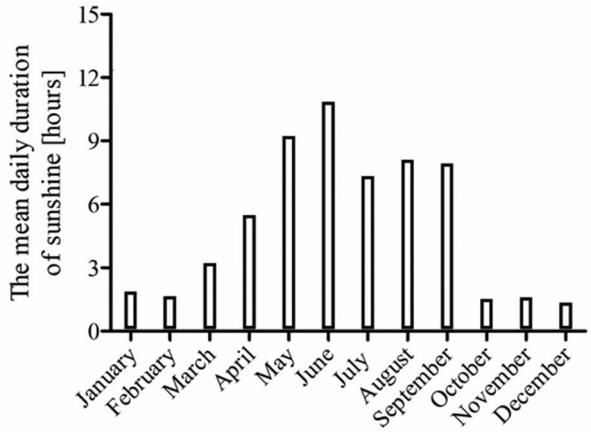


Figure 1. The mean duration of sunshine in all months of the year in Warsaw, Poland. Data for the mean daily sunshine hours were obtained from the Institute of Meteorology and Water Management, National Research Institute, Warsaw, Poland

Results

Participants' characteristics and baseline results

The study group consisted of 92 Caucasian patients (62 males and 30 females) with T2DM, history of previous MI, significant changes in one, two and/or three coronary arteries hospitalized due to ACS living in Warsaw (52°13'N, 21°02'E), Poland. Participants' mean (± standard deviation) age and BMI were: 69 (± 10) years and 29 (± 5) kg/m^2, respectively. Patients were classified into five subgroups based on age: 40–50 years, > 50–60 years, > 60–70 years, > 70–80 years and > 80 years with a following number of patients in consecutive age subgroups: 4, 10, 38, 24, 16. There were no significant differences in sex distribution among the five age subgroups (p = 0.08). Active smoking was declared by 32 patients (35%). TC and TG concentrations of 180 (± 60) mg/dL and 150 (± 90) mg/dL were observed, respectively. Hyperlipidemia was observed in 53 patients (58%) whereas hypertension was observed in most of them (83; 90%).

The median 25(OH)D concentration value in the whole group was 11 ng/mL (27.5 nmol/L), range: 4–28 ng/mL (10–70 nmol/L). All patients presented vitamin D deficiency — there were no patients with optimal 25(OH)D concentration (i.e. equal or greater than 30 ng/mL). Severe deficiency (the value below 10 ng/mL) was noticed in 30 patients (33%). Moderate deficiency (concentration equal or greater than 10 ng/mL and lower than 20 ng/mL) and mild deficiency (concentration equal or greater than 20 ng/mL and lower than 30 ng/mL) weres observed in 43 (47%) and 19 patients (20%), respectively. The mean duration of sunshine in all months of the year is presented in Figure 1.

The median (range) of mean daily duration of sunshine (analysis concerns 3 days before vitamin D measurements) was 1.1 hours (0.0–13.6 hours). The median of mean duration of sunshine per day significantly differed (p < 0.001) between the seasons of the year, and, as expected, was longer during summer months (May to October; median: 5.5 hours, range: 0.0–13.6 hours) and shorter during winter months (November to April: 0.8 hours, range: 0.0–11.8 hours). The examinations during summer months were performed in 49 (53%) patients, whereas during winter months in 43 (47%) patients.

Determinants of 25(OH)D concentration in the whole group

From selected variables examination date appeared as a significant determinant of 25(OH)D concentration (Table 1).

Table 1. Determinants of 25(OH)D concentration for all (n = 92) patients

	Determinants	β (SE)	95% CI	p
ln25(OH)D	Age	–0.07 (0.11)	–0.29–0.15	0.54
	Sex (♂/♀)	–0.02 (0.11)	–0.23–0.19	0.83
	BMI	–0.15 (0.11)	–0.36–0.06	0.17
	Smoking (yes/no)	–0.09 (0.10)	–0.29–0.12	0.40
	Hypertension (yes/no)	0.02 (0.10)	–0.18–0.22	0.83
	Hyperlipidemia (yes/no)	–0.17 (0.10)	–0.37–0.03	0.10
	Examination date (May–October/November–April)	–0.40 (0.09)	–0.60–0.20	< 0.001

♂ – male; ♀ – female; β – regression coefficient; BMI – body mass index; CI – confidence interval; SE – standard error

Table 2. Comparison of the selected parameters between the patients examined during the winter and summer months. Results for qualitative variables are presented as number and % of the whole group

	Patients examined during summer months (May–October)	Patients examined during winter months (November–April)	p
N and %	49 (53%)	43 (47%)	–
25(OH)D [ng/mL]	15 (6–28)	9 (4–26)	< 0.001
Age [years)]	70 ± 11	67 ± 10	0.17
Sex (♀/♂)	17 (18%)/32 (35%)	13 (14%)/30 (33%)	0.65
BMI [kg/m^2]	29 ± 4	30 ± 6	0.18
Smoking (yes/no)	14 (15%)/35 (38%)	18 (20%)/25 (27%)	0.18
Hypertension (yes/no)	42 (45%)/7 (8%)	41 (45%)/2 (2%)	0.12
Hyperlipidemia (yes/no)	25 (27%)/24 (26%)	28 (30%)/15 (17%)	0.17

♂ – male; ♀ – female; BMI – body mass index

Table 3. Determinants of 25(OH)D concentration in patients examined during summer months (n = 49)

	Determinants	β (SE)	95% CI	p
ln25(OH)D	Age	–0.24 (0.17)	–0.59–0.10	0.16
	Sex (♂/♀)	–0.03 (0.16)	–0.35–0.30	0.88
	BMI	0.01 (0.16)	–0.33–0.33	0.99
	Smoking (yes/no)	–0.11 (0.16)	–0.43–0.22	0.51
	Hypertension (yes/no)	–0.01 (0.16)	–0.33–0.30	0.95
	Hyperlipidemia (yes/no)	–0.24 (0.15)	–0.54–0.06	0.12

♂ – male; ♀ – female; β – regression coefficient; BMI – body mass index; CI – confidence interval; SE – standard error

Taking into account fact that examination date was the most significant determinant of 25(OH)D, and that the vitamin D can only be produced when there is UVB, which occurs only during six months in Poland, the whole group was divided into patients examined during winter and summer months to find significant determinants of the 25(OH)D concentration in these selected group of patients. Table 2 presents a comparison of the results of selected parameters between the patients examined during the winter and summer months.

Besides 25(OH)D concentration there were no significant differences between groups in analyzed clinical parameters.

Determinants of 25(OH)D concentration in patients examined during summer months

Tables 3 and 4 present results of the regression analysis considering selected variables as determinants of 25(OH)D concentration in patients examined during the summer months. There were no significant determinants

Table 4. Final step of the backward stepwise regression analysis considering selected variables as determinants of 25(OH)D concentration in patients examined during summer months (n = 49)

	Determinants	β (SE)	95% CI	p
ln25(OH)D	Age	–0.20 (0.14)	–0.48–0.08	0.16
	Hyperlipidemia (yes/no)	–0.24 (0.14)	–0.52–0.04	0.09

β – regression coefficient; CI – confidence interval; SE – standard error

Table 5. Results of the regression analysis considering selected variables as determinants of 25(OH)D concentration in patients examined during the winter months (n = 43)

	Determinants	β (SE)	95% CI	p
ln25(OH)D	Age	0.25 (0.18)	–0.11–0.60	0.17
	Sex (♂/♀)	0.06 (0.17)	–0.29–0.41	0.74
	BMI	–0.28 (0.17)	–0.63–0.06	0.11
	Smoking (yes/no)	–0.13 (0.16)	–0.46–0.20	0.44
	Hypertension (yes/no)	–0.01 (0.16)	–0.33–0.32	0.96
	Hyperlipidemia (yes/no)	–0.06 (0.17)	–0.41–0.29	0.74

♂ – male; ♀ – female; β – regression coefficient; BMI – body mass index; CI – confidence interval; SE – standard error

Table 6. Final step of the backward stepwise regression analysis considering selected variables as determinants of 25(OH)D concentration in patients examined during winter months (n = 43)

	Determinants	β (SE)	95% CI	p
ln25(OH)D	Age	0.26 (0.15)	–0.03–0.56	0.08
	BMI	–0.24 (0.15)	–0.54–0.06	0.12

♂ – male; ♀ – female; β – regression coefficient; BMI – body mass index; CI – confidence interval; SE – standard error

of ln25(OH)D in patients examined during the summer months. Age and hyperlipidemia were considered in the final step of the stepwise regression as the strongest predictors for the model.

Determinants of 25(OH)D in patients examined during winter months

Tables 5 and 6 present results of the regression analysis considering selected variables as determinants of 25(OH)D concentration in patients examined during winter months. There were no significant determinants of ln 25(OH)D in patients examined during the winter months. Age and BMI were considered in the final step of the stepwise regression as the strongest predictors for the model.

Discussion

The main finding of our study was that the strongest determinant of vitamin D status in Polish cardiac patients with identified (in previous studies [26, 27]) 25(OH)D deficiency is the date of examination. The main aim of our research project included this study and articles published previously [26, 27] was to indicate the group of cardiac patients who presented the lowest 25(OH)D concentration. The outcomes of our research project show that the patients with the most severe clinical characteristic, i.e. diabetic patients who experienced previous MI, with significant alterations in coronary arteries, hospitalized due to ACS, who were examined during winter months present extremely low 25(OH)D concentrations indicating very severe vitamin D deficiency. The median 25(OH)D concentration value in the above-mentioned group was ~9 ng/mL. Our results confirm published data for vitamin D concentration for cardiac patients from another region of Poland (Tarnów; 50°01'45''N, 20°58'18''E). Tokarz et al. [34] presented that median serum 25(OH)D concentration in patients with acute MI was ~7 ng/mL.

Low 25(OH)D concentration in hospitalized cardiac patient group may be associated with their clinical characteristics. Vitamin D plays a role in the whole dynamic process from the initiation of endothelial dysfunction to the development of atherosclerosis. Hypovitaminosis D alters

a range of pathways in endothelial cells, extracellular matrix, and vascular smooth muscle, which are implicated in atherosclerosis pathogenesis [35–37]. There have been an increasing number of review papers highlighting that vitamin D deficiency is associated with an increased risk of developing CVD given to the relationship between low vitamin D concentration and e.g. diabetes, dyslipidemia, atherosclerosis, endothelial dysfunction, and hypertension [9, 38–40]. Our results indicated that patients with low 25(OH)D concentration presented more severe conditions than those with higher values of 25(OH)D which is in line with outcomes from, e.g., the NHANES III [41]. The NHANES III study included a representative sample of the American population showed a significant increase in the prevalence of hypertension, diabetes mellitus, obesity, and hypertriglyceridemia in patients with low 25(OH)D concentration (< 21 ng/mL) compared to those with higher concentrations [25(OH)D concentration > 37 ng/mL] [41]. Concentrations below 20 ng/l are linked independently to cardiovascular morbidity and mortality [42]. Diabetic cardiac patients from central Poland achieved lower results compared to the results from the NHANES epidemiological study [41, 43–45]. In the NHANES cohort study, only 5% of participants had values below the cutoff of 11 ng/mL [43]. It confirms intercontinental differences in 25(OH)D concentration [46]. Based on the review of literature, Hilger et al. [46] demonstrated significantly higher 25(OH)D concentration in North America compared to Europe or the Middle East/Africa region.

The results of the presented study (mean, median) are more or less comparable (slightly lower) with the results of epidemiological data on the vitamin D status from general population from central Europe [47] and particularly from Poland, where several authors proved massive vitamin D deficiency [48–51]. Pludowski et al. [47] in 2014 summarized the available data on the supply of vitamin D and the epidemiology of its deficiency in Central European populations, concluded that most people living in Central and Western Europe have serum 25(OH)D concentrations below optimal values (< 30–50 ng/mL). In Poland, the average concentration of 25(OH)D in late winter and early spring in about six thousand healthy residents of 22 Polish cities was about 18.0 ng/mL. In approximately 66% of subjects, the concentration of 25(OH)D was below 20 ng/mL, and optimal values (i.e. > 30 ng/mL) were observed only in less than 10% of the Polish population [48]. Similar results were shown by Kmieć et al. [52], more than 80% of adults living only in the north of Poland (Gdańsk, Gdynia, Sopot) demonstrated the 25(OH)D concentration below 20 ng/mL, only 2.5% presented optimal concentration of 25(OH)D, in winter the 25(OH)D concentration was even about 13 ng/mL [53]. It should be emphasized that this study was also carried out only in the winter months (from February to mid-April) [52]. Such a value was confirmed in an urban population of elderly women living in central Poland (Warsaw) [54]. In the winter months (between December and March) the 25(OH)D concentration in this study sample was 13.6 ng/mL. In addition, 83.2% of the studied women had a concentration of 25(OH)D below 20 ng/mL (in this group 35% were classified as a severe vitamin D deficiency, i.e. 25(OH)D < 10 ng/mL) and only 4% above 30 ng/mL [54]. In another study conducted in Poland, which included more than one hundred residents (82 women and 50 men aged from 41 to 81 years) of Kraków, the southern part of Poland, it was shown that the average concentration of 25(OH)D in the winter months was 16.7 ng/mL, and the deficiency concerned 90.2% of the studied group [55].

Besides many studies confirming the association between low 25(OH)D concentration and adverse cardiac events, results of the several trials aimed at evaluation of the effect of vitamin D supplementation on cardiovascular outcomes have been inconclusive or contradictory [38, 56]. Results from published randomized controlled trials (RCTs) indicated that vitamin D supplementation is ineffective in improving cardiovascular health among different patient populations [57]. Mirhosseini et al. [7] and Raed et al. [8] suggested that the problem was too little vitamin D given to the participants. Mirhosseini et al. [7] stated that at least 100 µg/day of vitamin D is required to achieve and maintain a serum 25(OH)D concentration of 100 nmol/L.

Kennel et al. [24] in their comprehensive review article asked the question: how much vitamin D is needed to correct severe vitamin D deficiency (i.e. values below 10 ng/mL)?; and answered that the usually applied strategy is to prescribe a "loading dose" e.g., 50 000 IU of vitamin D orally once weekly for 2–3 months. The US Endocrine Society suggests 1,500–2,000 IU/day of vitamin D is needed for adults to maintain 25(OH)D above the optimal level of 75 nmol/L [58]. Pilz et al. suggested that the RCTs were not adequately designed to address extraskeletal events, and did not focus on vitamin D-deficient individuals [44, 59]. It was underlined that more emphasis should be placed on well-designed RTCs among severely vitamin D-deficient populations who would mostly benefit from vitamin D treatment [25]. Recent, first individual participant data-derived estimates may offer improved dietary recommendations for vitamin D because the underpinning modeling captures the between-person variability in response of serum 25(OH)D to vitamin D intake [60].

Results from our research project may help in the identification of the severely vitamin D-deficient cardiac population. It should be highlighted here that hypovitaminosis D in our study group of cardiac diabetic patients with severe medical conditions may result from many reasons including

environmental and/or clinical reasons. According to the vitamin D supplementation guideline published by Pludowski et al. [11], for patients with a laboratory-confirmed vitamin D deficiency (concentration lower than 20 ng/mL), like our population study group, a vitamin D treatment should be implemented — an age- and body weight-dependent therapeutic dosage should be administered with a treatment duration of 1–3 months.

Treatment including e.g. sun exposure activities and dietary intake may not be enough to achieve and maintain the target — minimum serum 25(OH)D concentration of at least 30 ng/mL (75 nmol/L). Additional vitamin D supplementation could be needed taking into account the fact that with the exception of fatty fish and meat [61] (red meat is also a risk factor for CVD, so should not be recommended [62]) the vitamin D content of most foods, including fortified dairy products, is relatively low to nonexistent [24]. The results of the National Multicentre Health Survey (WOBASZ) showed that the Polish population with established CVD is characterized by a low level of knowledge of non-pharmacological methods of preventing CVD [6] and the quality of dietary habits falls far short of the recommendations relevant for CVD prevention [63]. In Poland, there is a limited number of vitamin D-fortified foods and recommendations of vitamin D supplementation are probably not properly implemented [64].

The report of the European Food Safety Authority [65] indicated that the dietary intake of Vitamin D is commonly too low in European countries. In Poland, vitamin D dietary intake is significantly low — the range of mean daily vitamin D intake was between 2.92 µg/capita/day and 4.16 µg/capita/day in different age groups from 14 to more than 70 years [66]. Additional vitamin D supplementation in Polish cardiac patients seems to be necessary and implemented as soon as possible.

Grant et al. suggested that there could be a significant reduction in many healthcare costs related to diseases that have been associated with vitamin D deficiency [67, 68]. Vitamin D insufficiency is linked to important risk factors of leading causes of death [69]. Clinicians and/or healthcare providers should be aware of the connection and offer adequate interventions to increase 25(OH)D concentration, especially in minority groups [70, 71]. As a good example, recently (2016), the US Food and Drug Agency approved the addition of vitamin D to beverages made from edible plants intended as milk alternatives (also, orange juice) [72]. These are correct steps in the right direction, which can be adapted by e.g. Poland [11]. Programs aimed at improving knowledge level about the benefits of vitamin D supplementation could help reduce widespread vitamin D deficiency. It could be worthwhile to mention here that magnesium should also be supplemented to increase the conversion of vitamin D3 to 25(OH)D3 [73].

The limitations of this study are as follows. Lack of information on the treatment duration of prescribed statins. In each patient, serum phosphate, calcium, and parathyroid hormone concentrations were measured initially to include or exclude consecutive patients. We assessed only whether or not the patient values are in normal values and did not include data for the following variables in our analyses. The examinations were performed in patients living in urban areas of central Poland. To translate the obtained results into the entire Polish population, future examinations should be extended to the inhabitants of other regions of Poland. The study group consisted of 92 patients, however, statistical sub-analyses aimed at finding patients with the lowest values of 25(OH)D concentration limited the sample size in selected patient subgroups leading to reduced statistical power and caution in clinical decision making. Other factors like socioeconomic status (e.g. education level) may influence vitamin D concentration [41, 74], we did not take into account such factors in our analyses.

Conclusions

The population of cardiac patients from central Poland is a vitamin D-deficient group. In these patients, vitamin D treatment seems to be necessary and implemented as soon as possible.

Authors contributions

Conceptualization, EAD; data curation, EAD; investigation, EAD; methodology, EAD; project administration, EAD; resources, EAD; supervision, EAD, PP, WBG, MD; validation, EAD, JSG, PP, WBG, TS, MD; writing — original draft, EAD, JSG, WBG; writing — review and editing, EAD, JSG, PP, WBG, TS, MD. All authors approved the final version of the manuscript prior to submission.

Conflict of interest

WBG receives funding from Bio-Tech Pharmacal, Inc. (Fayetteville, AR, USA). Other authors: EAD, JSG, PP, TS, MD declare no conflict of interest.

Funding

This research was partly funded by a statutory grant to Cardiology Clinic of Physiotherapy Division from the 2nd Faculty of Medicine, Medical University of Warsaw, Poland, grant number 2F5/PM2/16/16.

Streszczenie

Wstęp. Niedobór witaminy D jest problemem ogólnoświatowym o różnych konsekwencjach zdrowotnych. Witamina D może obniżać ryzyko niewydolności serca, jednak dowody świadczące o skuteczności suplementacji witaminą D na utrzymanie zdrowia układu sercowo-naczyniowego są sprzeczne z powodu braku odpowiedniej liczby i jakości badań klinicznych. Przyczyny braku jednoznacznych efektów potwierdzających pozytywny wpływ suplementacji witaminy D mogą być co najmniej trzy: 1) suplementacja zbyt małą ilością witaminy D lub 2) brak włączenia do badania tylko populacji z ciężkim niedoborem witaminy D, lub 3) czas trwania suplementacji. Celem pracy była charakterystyka grupy pacjentów kardiologicznych, u których stwierdzono w poprzednich badaniach najniższe stężenia 25-hydroksywitaminy D [25(OH)D].

Materiał i metody. Analizie poddano wyniki 92 chorych kardiologicznych z cukrzycą w wieku 41–89 lat, którzy przeżyli zawał serca z istotnymi zmianami w tętnicach wieńcowych, hospitalizowanych z powodu ostrego zespołu wieńcowego, mieszkających w Warszawie.

Wyniki. Mediana stężenia 25(OH)D w badanej populacji wyniosła 11 ng/ml (zakres: 4–28 ng/ml). Jedynym istotnym determinantem stężenia 25(OH)D był okres badania; stężenie było wyższe latem niż zimą.

Wnioski. Leczenie witaminą D u polskich pacjentów kardiologicznych w celu osiągnięcia optymalnego stężenia, tj. 30 ng/ml (75 nmol/l), wydaje się konieczne i powinno być jak najszybciej wdrożone.

Słowa kluczowe: witamina D, niedobór witaminy D, choroby układu krążenia

Folia Cardiologica 2022; 17, 1: 1–10

References

1. Stewart J, Manmathan G, Wilkinson P. Primary prevention of cardiovascular disease: a review of contemporary guidance and literature. JRSM Cardiovasc Dis. 2017; 6: 2048004016687211, doi: 10.1177/2048004016687211, indexed in Pubmed: 28286646.
2. Benjamin EJ, Blaha MJ, Chiuve SE, et al. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics-2017 update: a report from the American Heart Association. Circulation. 2017; 135(10): e146–e603, doi: 10.1161/CIR.0000000000000485, indexed in Pubmed: 28122885.
3. Turek-Jabrocka R, Szafraniec K, Pach D, et al. Metabolic syndrome as a useful tool in the identification of persons with an increased risk of nonfatal cardiovascular events in the Polish urban population — a prospective study. Folia Cardiologica. 2016; 11(4): 261–267, doi: 10.5603/fc.2016.0067.
4. Cieśliński A, Pająk A, Podolec P, Rynkiewicz A. Ogólnopolski program prewencji choroby wieńcowej POLSCREEN. Termedia Wydawnictwo Medyczne, Poznań 2006: 27–34.
5. Kozela M, Szafraniec K, Broda G, et al. POLKARD Study Group. Detection and treatment of hypercholesterolemia in primary health care. Results of the POLKARD program of the Ministry of Health of the Republic of Poland. Pol Arch Med Wewn. 2012; 122(4): 154–161, doi: 10.20452/pamw.1220, indexed in Pubmed: 22495111.
6. Waśkiewicz A, Piotrowski W, Sygnowska E, et al. Quality of nutrition and health knowledge in subjects with diagnosed cardio-vascular diseases in the Polish population — National Multicentre Health Survey (WOBASZ). Kardiol Pol. 2008; 66(5): 507–13, discussion 514, indexed in Pubmed: 18537058.
7. Mirhosseini N, Vatanparast H, Kimball SM. The association between serum 25(OH)D status and blood pressure in participants of a community-based program taking vitamin D supplements. Nutrients. 2017; 9(11): 1244, doi: 10.3390/nu9111244, indexed in Pubmed: 29135923.
8. Raed A, Bhagatwala J, Zhu H, et al. Dose responses of vitamin D3 supplementation on arterial stiffness in overweight African Americans with vitamin D deficiency: a placebo controlled randomized trial. PLoS One. 2017; 12(12): e0188424, doi: 10.1371/journal.pone.0188424, indexed in Pubmed: 29216203.
9. Muscogiuri G, Annweiler C, Duval G, et al. Vitamin D and cardiovascular disease: From atherosclerosis to myocardial infarction and stroke. Int J Cardiol. 2017; 230: 577–584, doi: 10.1016/j.ijcard.2016.12.053, indexed in Pubmed: 28043680.
10. Wimalawansa SJ. Vitamin D and cardiovascular diseases: causality. J Steroid Biochem Mol Biol. 2018; 175: 29–43, doi: 10.1016/j.jsbmb.2016.12.016, indexed in Pubmed: 28027913.
11. Pludowski P, Holick MF, Grant WB, et al. Vitamin D supplementation guidelines. J Steroid Biochem Mol Biol. 2018; 175: 125–135, doi: 10.1016/j.jsbmb.2017.01.021, indexed in Pubmed: 28216084.
12. Wang TJ, Pencina MJ, Booth SL, et al. Vitamin D deficiency and risk of cardiovascular disease. Circulation. 2008; 117(4): 503–511, doi: 10.1161/CIRCULATIONAHA.107.706127, indexed in Pubmed: 18180395.
13. Drechsler C, Pilz S, Obermayer-Pietsch B, et al. Vitamin D deficiency is associated with sudden cardiac death, combined cardiovascular events, and mortality in haemodialysis patients. Eur Heart J. 2010; 31(18): 2253–2261, doi: 10.1093/eurheartj/ehq246, indexed in Pubmed: 20688781.
14. Vacek JL, Vanga SR, Good M, et al. Vitamin D deficiency and supplementation and relation to cardiovascular health. Am J Cardiol. 2012; 109(3): 359–363, doi: 10.1016/j.amjcard.2011.09.020, indexed in Pubmed: 22071212.
15. Correia LCL, Sodré F, Garcia G, et al. Relation of severe deficiency of vitamin D to cardiovascular mortality during acute coronary syndromes. Am J Cardiol. 2013; 111(3): 324–327, doi: 10.1016/j.amjcard.2012.10.006, indexed in Pubmed: 23174181.

16. Porto CM, De Lima Silva V, da Luz JS, et al. Association between vitamin D deficiency and heart failure risk in the elderly. ESC Heart Fail. 2018; 5(1): 63–74, doi: 10.1002/ehf2.12198, indexed in Pubmed: 28817241.
17. Hill A. The environment and disease: association or causation? JR Soc Med. 2015; 108(1): 32–37, doi: 10.1177/0141076814562718, indexed in Pubmed: 25572993.
18. Weyland PG, Grant WB, Howie-Esquivel J. Does sufficient evidence exist to support a causal association between vitamin D status and cardiovascular disease risk? An assessment using Hill's criteria for causality. Nutrients. 2014; 6(9): 3403–3430, doi: 10.3390/nu6093403, indexed in Pubmed: 25184368.
19. Trehan N, Afonso L, Levine DL, et al. Vitamin D deficiency, supplementation, and cardiovascular health. Crit Pathw Cardiol. 2017; 16(3): 109–118, doi: 10.1097/HPC.0000000000000122, indexed in Pubmed: 28742648.
20. Al Mheid I, Quyyumi AA. Vitamin D and cardiovascular disease: controversy unresolved. J Am Coll Cardiol. 2017; 70(1): 89–100, doi: 10.1016/j.jacc.2017.05.031, indexed in Pubmed: 28662812.
21. Melamed ML, Michos ED, Post W, et al. 25-hydroxyvitamin D levels and the risk of mortality in the general population. Arch Intern Med. 2008; 168(15): 1629–1637, doi: 10.1001/archinte.168.15.1629, indexed in Pubmed: 18695076.
22. Grant WB, Karras SN, Bischoff-Ferrari HA, et al. Do studies reporting 'U'-shaped serum 25-hydroxyvitamin D-health outcome relationships reflect adverse effects? Dermatoendocrinol. 2016; 8(1): e1187349, doi: 10.1080/19381980.2016.1187349, indexed in Pubmed: 27489574.
23. Haines ST, Park SK. Vitamin D supplementation: what's known, what to do, and what's needed. Pharmacotherapy. 2012; 32(4): 354–382, doi: 10.1002/phar.1037, indexed in Pubmed: 22461123.
24. Kennel KA, Drake MT, Hurley DL. Vitamin D deficiency in adults: when to test and how to treat. Mayo Clin Proc. 2010; 85(8): 752–757, doi: 10.4065/mcp.2010.0138, indexed in Pubmed: 20675513.
25. Grant WB, Boucher BJ, Bhattoa HP, et al. Why vitamin D clinical trials should be based on 25-hydroxyvitamin D concentrations. J Steroid Biochem Mol Biol. 2018; 177: 266–269, doi: 10.1016/j.jsbmb.2017.08.009, indexed in Pubmed: 28842142.
26. Dziedzic EA, Przychodzeń S, Dąbrowski M. The effects of vitamin D on severity of coronary artery atherosclerosis and lipid profile of cardiac patients. Arch Med Sci. 2016; 12(6): 1199–1206, doi: 10.5114/aoms.2016.60640, indexed in Pubmed: 27904508.
27. Dziedzic EA, Gąsior JS, Pawłowski M, et al. Association of vitamin D deficiency and degree of coronary artery disease in cardiac patients with type 2 diabetes. J Diabetes Res. 2017; 2017: 3929075, doi: 10.1155/2017/3929075, indexed in Pubmed: 29230421.
28. Krzywanski J, Mikulski T, Krysztofiak H, et al. Seasonal vitamin D status in Polish elite athletes in relation to sun exposure and oral supplementation. PLoS One. 2016; 11(10): e0164395, doi: 10.1371/journal.pone.0164395, indexed in Pubmed: 27732653.
29. Sahota O. Understanding vitamin D deficiency. Age Ageing. 2014; 43(5): 589–591, doi: 10.1093/ageing/afu104, indexed in Pubmed: 25074537.
30. Heaney RP. Vitamin D in health and disease. Clin J Am Soc Nephrol. 2008; 3(5): 1535–1541, doi: 10.2215/CJN.01160308, indexed in Pubmed: 18525006.
31. Holick MF, Binkley NC, Bischoff-Ferrari HA, et al. Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011; 96(7): 1911–1930, doi: 10.1210/jc.2011-0385, indexed in Pubmed: 21646368.
32. Al-Khalidi B, Kimball SM, Rotondi MA, et al. Standardized serum 25-hydroxyvitamin D concentrations are inversely associated with cardiometabolic disease in U.S. adults: a cross-sectional analysis of NHANES, 2001-2010. Nutr J. 2017; 16(1): 16, doi: 10.1186/s12937-017-0237-6, indexed in Pubmed: 28241878.
33. Engelsen O. The relationship between ultraviolet radiation exposure and vitamin D status. Nutrients. 2010; 2(5): 482–495, doi: 10.3390/nu2050482, indexed in Pubmed: 22254036.
34. Tokarz A, Kusnierz-Cabala B, Kuźniewski M, et al. Seasonal effect of vitamin D deficiency in patients with acute myocardial infarction. Kardiol Pol. 2016; 74(8): 786–792, doi: 10.5603/KP.a2016.0002, indexed in Pubmed: 26779851.
35. Brewer LC, Michos ED, Reis JP. Vitamin D in atherosclerosis, vascular disease, and endothelial function. Curr Drug Targets. 2011; 12(1): 54–60, doi: 10.2174/138945011793591617, indexed in Pubmed: 20795937.
36. Kassi E, Adamopoulos C, Basdra EK, et al. Role of vitamin D in atherosclerosis. Circulation. 2013; 128(23): 2517–2531, doi: 10.1161/CIRCULATIONAHA.113.002654, indexed in Pubmed: 24297817.
37. Dalan R, Liew H, Tan W, et al. Vitamin D and the endothelium: basic, translational and clinical research updates. IJC Metabolic & Endocrine. 2014; 4: 4–17, doi: 10.1016/j.ijcme.2014.06.003.
38. McGreevy C, Williams D. New insights about vitamin D and cardiovascular disease: a narrative review. Ann Intern Med. 2011; 155(12): 820–826, doi: 10.7326/0003-4819-155-12-201112200-00004, indexed in Pubmed: 22184689.
39. Pludowski P, Holick MF, Pilz S, et al. Vitamin D effects on musculoskeletal health, immunity, autoimmunity, cardiovascular disease, cancer, fertility, pregnancy, dementia and mortality-a review of recent evidence. Autoimmun Rev. 2013; 12(10): 976–989, doi: 10.1016/j.autrev.2013.02.004, indexed in Pubmed: 23542507.
40. Pilz S, Verheyen N, Grübler MR, et al. Vitamin D and cardiovascular disease prevention. Nat Rev Cardiol. 2016; 13(7): 404–417, doi: 10.1038/nrcardio.2016.73, indexed in Pubmed: 27150190.
41. Martins D, Wolf M, Pan D, et al. Prevalence of cardiovascular risk factors and the serum levels of 25-hydroxyvitamin D in the United States: data from the Third National Health and Nutrition Examination Survey. Arch Intern Med. 2007; 167(11): 1159–1165, doi: 10.1001/archinte.167.11.1159, indexed in Pubmed: 17563024.
42. Fanari Z, Hammami S, Hammami MB, et al. Vitamin D deficiency plays an important role in cardiac disease and affects patient outcome: Still a myth or a fact that needs exploration? J Saudi Heart Assoc. 2015; 27(4): 264–271, doi: 10.1016/j.jsha.2015.02.003, indexed in Pubmed: 26557744.
43. Yetley EA. Assessing the vitamin D status of the US population. Am J Clin Nutr. 2008; 88(2): 558S–564S, doi: 10.1093/ajcn/88.2.558S, indexed in Pubmed: 18689402.
44. Mazidi M, Michos ED, Banach M. The association of telomere length and serum 25-hydroxyvitamin D levels in US adults: the National Health and Nutrition Examination Survey. Arch Med Sci. 2017; 13(1): 61–65, doi: 10.5114/aoms.2017.64714, indexed in Pubmed: 28144256.
45. Zadshir A, Tareen N, Pan D, et al. The prevalence of hypovitaminosis D among US adults: data from the NHANES III. Ethn Dis. 2005; 15 (4 Suppl 5): 97–101, indexed in Pubmed: 16315387.
46. Hilger J, Friedel A, Herr R, et al. A systematic review of vitamin D status in populations worldwide. Br J Nutr. 2014; 111(1): 23–45, doi: 10.1017/S0007114513001840, indexed in Pubmed: 23930771.

47. Pludowski P, Grant WB, Bhattoa HP, et al. Vitamin D status in Central Europe. Int J Endocrinol. 2014; 2014: 589587, doi: 10.1155/2014/589587, indexed in Pubmed: 24790600.
48. Płudowski P, Ducki C, Konstantynowicz J, et al. Vitamin D status in Poland. Pol Arch Med Wewn. 2016; 126(7-8): 530–539, doi: 10.20452/pamw.3479, indexed in Pubmed: 27509842.
49. Pludowski P, Konstantynowicz J, Jaworski M, et al. Assessment of supply of vitamin D in the adult population in Poland. Standardy Med Pediatria. 2014; 4: 609–617.
50. Rusińska A, Płudowski P, Walczak M, et al. Vitamin D supplementation guidelines for general population and groups at risk of vitamin D deficiency in poland-recommendations of the Polish Society of Pediatric Endocrinology and Diabetes and the expert panel with participation of national specialist consultants and representatives of scientific societies — 2018 update. Front Endocrinol (Lausanne). 2018; 9: 246, doi: 10.3389/fendo.2018.00246, indexed in Pubmed: 29904370.
51. Wyskida M, Owczarek A, Szybalska A, et al. Socio-economic determinants of vitamin D deficiency in the older Polish population: results from the PolSenior study. Public Health Nutr. 2018; 21(11): 1995–2003, doi: 10.1017/S1368980017003901, indexed in Pubmed: 29352837.
52. Kmieć P, Żmijewski M, Waszak P, et al. Vitamin D deficiency during winter months among an adult, predominantly urban, population in Northern Poland. Endokrynol Pol. 2014; 65(2): 105–113, doi: 10.5603/EP.2014.0015, indexed in Pubmed: 24802733.
53. Kmieć P, Żmijewski M, Lizakowska-Kmieć M, et al. Widespread vitamin D deficiency among adults from northern Poland (54° N) after months of low and high natural UVB radiation. Endokrynol Pol. 2015; 66(1): 30–38, doi: 10.5603/EP.2015.0006, indexed in Pubmed: 25754279.
54. Napiórkowska L, Budlewski T, JakubasKwiatkowska W, et al. Prevalence of low serum vitamin D concentration in an urban population of elderly women in Poland. Pol Arch Med Wewn. 2009; 119(11): 699–703, doi: 10.20452/pamw.815.
55. Trofimiuk-Muldner M, Kieć-Klimczak M, Hubalewska-Dydejczyk A. Niedobór witaminy D w populacji miasta Krakowa — wyniki wstępne. Endokrynol Pol. 2012; 63(Suppl. A): 160.
56. Carvalho LS, Sposito AC. Vitamin D for the prevention of cardiovascular disease: Are we ready for that? Atherosclerosis. 2015; 241(2): 729–740, doi: 10.1016/j.atherosclerosis.2015.06.034, indexed in Pubmed: 26135478.
57. Veloudi P, Jones G, Sharman JE. Effectiveness of vitamin D supplementation for cardiovascular health outcomes. Pulse (Basel). 2016; 4(4): 193–207, doi: 10.1159/000452742, indexed in Pubmed: 28229054.
58. Pramyothin P, Holick MF. Vitamin D supplementation: guidelines and evidence for subclinical deficiency. Curr Opin Gastroenterol. 2012; 28(2): 139–150, doi: 10.1097/MOG.0b013e32835004dc, indexed in Pubmed: 22274617.
59. Pilz S, Kienreich K, Tomaschitz A, et al. Vitamin D and cardiovascular disease: update and outlook. Scand J Clin Lab Invest Suppl. 2012; 243: 83–91, doi: 10.3109/00365513.2012.681972, indexed in Pubmed: 22536768.
60. Cashman KD, Ritz C, Kiely M, et al. Improved dietary guidelines for vitamin D: application of individual participant data (IPD)-level meta-regression analyses. Nutrients. 2017; 9(5): 469, doi: 10.3390/nu9050469, indexed in Pubmed: 28481259.
61. Crowe FL, Steur M, Allen NE, et al. Plasma concentrations of 25-hydroxyvitamin D in meat eaters, fish eaters, vegetarians and vegans: results from the EPIC-Oxford study. Public Health Nutr. 2011; 14(2): 340–346, doi: 10.1017/S1368980010002454, indexed in Pubmed: 20854716.
62. Bechthold A, Boeing H, Schwedhelm C, et al. Food groups and risk of coronary heart disease, stroke and heart failure: a systematic review and dose-response meta-analysis of prospective studies. Crit Rev Food Sci Nutr. 2019; 59(7): 1071–1090, doi: 10.1080/10408398.2017.1392288, indexed in Pubmed: 29039970.
63. Waśkiewicz A, Szcześniewska D, Szostak-Węgierek D, et al. Are dietary habits of the Polish population consistent with the recommendations for prevention of cardiovascular disease? — WOBASZ II project. Kardiol Pol. 2016; 74(9): 969–977, doi: 10.5603/KP.a2016.0003, indexed in Pubmed: 26779852.
64. Karczmarewicz E, Czekuć-Kryśkiewicz E, Płudowski P, et al. Effect of vitamin D status on pharmacological treatment efficiency: Impact on cost-effective management in medicine. Dermatoendocrinol. 2013; 5(2): 299–304, doi: 10.4161/derm.25279, indexed in Pubmed: 24194969.
65. European Food Safety Authority. Scientific opinion on the tolerable upper intake level of vitamin D. EFSA Journal. 2012; 10(7): 2813, doi: 10.2903/j.efsa.2012.2813.
66. Lichthammer A, Nagy B, Orbán C, et al. A comparative study of eating habits, calcium and vitamin D intakes in the population of Central--Eastern European countries. New Medicine. 2015; 19(2): 66–70, doi: 10.5604/14270994.1169799.
67. Grant WB. An estimate of the global reduction in mortality rates through doubling vitamin D levels. Eur J Clin Nutr. 2011; 65(9): 1016––1026, doi: 10.1038/ejcn.2011.68, indexed in Pubmed: 21731036.
68. Grant WB, Whiting SJ, Schwalfenberg GK, et al. Estimated economic benefit of increasing 25-hydroxyvitamin D concentrations of Canadians to or above 100 nmol/L. Dermatoendocrinol. 2016; 8(1): e1248324, doi: 10.1080/19381980.2016.1248324, indexed in Pubmed: 27942348.
69. Forrest KYZ, Stuhldreher WL. Prevalence and correlates of vitamin D deficiency in US adults. Nutr Res. 2011; 31(1): 48–54, doi: 10.1016/j.nutres.2010.12.001, indexed in Pubmed: 21310306.
70. Whayne TF. Vitamin d: popular cardiovascular supplement but benefit must be evaluated. Int J Angiol. 2011; 20(2): 63–72, doi: 10.1055/s-0031-1279679, indexed in Pubmed: 22654467.
71. Kühn T. Vitamin D deficiency in urban Poland: what are the implications? Pol Arch Med Wewn. 2016; 126(7-8): 468–470, doi: 10.20452/pamw.3531, indexed in Pubmed: 27578219.
72. Department of Health and Human Services. Food and Drug Administration. Food additives permitted for direct addition to food for human consumption. Federal Register. 2016; 81(137): 46578–46582.
73. Zittermann A. Magnesium deficit ? overlooked cause of low vitamin D status? BMC Med. 2013; 11: 229, doi: 10.1186/1741-7015-11-229, indexed in Pubmed: 24228832.
74. Shirazi L, Almquist M, Malm J, et al. Determinants of serum levels of vitamin D: a study of life-style, menopausal status, dietary intake, serum calcium, and PTH. BMC Womens Health. 2013; 13: 33, doi: 10.1186/1472-6874-13-33, indexed in Pubmed: 23945218.

Folia Cardiologica 2022
vol. 17, no. 1, pages 11–19
DOI: 10.5603/FC.a2022.0001

ISSN 2353–7752
e-ISSN 2353–7760

Prevalence and control of atrial hypertension in Mazovian men and women enrolled in the POLASPIRE study

Rozpowszechnienie oraz kontrola leczenia nadciśnienia tętniczego u kobiet i mężczyzn włączonych do badania POLASPIRE w województwie mazowieckim

Małgorzata Setny[1], Radosław Piątkowski[2], Arkadiusz Rak[3], Agnieszka Krzykwa[1], Piotr Kułak[4], Piotr Jankowski[5, 6], Dariusz A. Kosior[4, 7]

[1]Clinical Cardiology Center, Central Clinical Hospital of the Ministry of Interior and Administration, Warsaw, Poland
[2]1st Chair and Department of Cardiology, Central Teaching Clinical Hospital of Medical University of Warsaw, Warsaw, Poland
[3]Cardiology Department, Cardiac Center, Józefów, Poland
[4]Department of Cardiology and Hypertension with the Electrophysiological Lab, Central Clinical Hospital of the Ministry of Interior and Administration, Warsaw, Poland
[5]Department of Internal Medicine and Geriatric Cardiology, Centre of Postgraduate Medicine Education, Warsaw, Poland
[6]Department of Epidemiology and Health Promotion, School of Public Health, Centre of Postgraduate Medical Education, Warsaw, Poland
[7]Mossakowski Medical Research Centre Polish Academy of Sciences, Warsaw, Poland

Abstract

Introduction. Arterial hypertension (AH) is one of the major modifiable risk factors for cardiovascular disease, which increases cardiovascular morbidity and mortality.

The aim of this study was to evaluate AH prevalence and treatment control in men and women with coronary artery disease.

Material and methods. The study included patients enrolled in the POLASPIRE trial in the Mazovian region. Definitions of risk factors and therapeutic targets were based on the 2016 European Society of Cardiology guidelines for cardiovascular prevention.

Results. AH was diagnosed in 88% of women and 81% of men ($p = 0.56$). Among AH patients, women were older than men ($p < 0.001$). There were no statistically significant gender-related differences in the prevalence of diabetes mellitus ($p = 1.00$), dyslipidemia ($p = 0.42$), and obesity ($p = 0.47$). Women were more likely to have a history of stroke ($p < 0.001$), reduced glomerular filtration rate values ($p < 0.001$), elevated low-density lipoprotein cholesterol ($p = 0.029$), and non-high-density lipoprotein cholesterol levels ($p = 0.022$) as well as echocardiographic features of left ventricular diastolic dysfunction ($p = 0.006$). 51% of women and 50% of men ($p = 1.00$) did not achieve blood pressure targets. There were no significant differences between groups regarding pharmacotherapy for AH.

Conclusions. The prevalence of AH in patients with coronary artery disease is high. A significant percentage of men and women do not achieve recommended blood pressure values. There is a need to improve the effectiveness of antihypertensive treatment.

Key words: arterial hypertension, coronary artery disease, risk factors, goal attainment

Folia Cardiologica 2022; 17, 1: 11–19

Address for correspondence: Małgorzata Setny MD, Centrum Kardiologii Klinicznej, Centralny Szpital Kliniczny MSWiA, ul. Wołoska 137, 02–507 Warszawa, Poland, e-mail: malgorzata.setny@cskmswia.pl

Introduction

Arterial hypertension (AH) is one of the modifiable risk factors of cardiovascular disease (CVD), whose prevalence in the population is very high. In 2011 NATPOL study, it was found in 37% of men and 29% of women aged 18–79 years [1], and in 2013–2014 WOBASZ II survey it was confirmed in 46% of men and 40% of women aged 19–99 years [2]. Moreover, according to the World Health Organization (WHO) assessment performed in 2015, one in four men and one in five women, that is, more than one billion people worldwide, suffered from AH [3].

The persistence of elevated blood pressure (BP) leads to the development of numerous complications. AH increases morbidity and mortality due to coronary artery disease (CAD), heart failure, and stroke [4, 5], and, following diabetes mellitus (DM), is the second cause of chronic kidney disease (CKD) [6].

AH-related complications are the leading cause of premature deaths worldwide [3]. They also reduce the productivity of sick people as a consequence of their absence or inability to work, which poses a major economic burden in many countries. A number of studies have shown that a 10 mm Hg reduction in systolic BP (SBP) or a 5 mm Hg reduction in diastolic BP (DBP) is associated with a reduction in major cardiovascular (CV) incidents by about 20%, strokes by about 35%, coronary incidents by about 20%, heart failure by about 40%, and overall mortality by about 13% [7, 8].

The aim of the present study was to evaluate the incidence of organ complications, comorbidities, and the type of administered pharmacotherapy in men and women with AH who were enrolled in the POLASPIRE study [9] as representatives of the Polish Mazovian province population.

Material and methods

The study group consisted of AH patients aged ≥ 18 and < 80 years enrolled in the POLASPIRE trial in the Mazovian region, who were hospitalized for acute coronary syndrome (ACS), i.e., ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), or unstable angina (UA), or who underwent elective percutaneous coronary angioplasty (PCI) or elective coronary artery bypass grafting (CABG) within 6 to 24 months prior to inclusion. The patients were recruited from one university hospital and one municipal hospital. An approval was obtained from a local bioethics committee, and all participants signed an informed consent form.

The study comprised two independent parts conducted between 2016 and 2017.

The first one included an analysis of patients' medical history from the time of hospitalization for the qualifying incident. Individuals who met the inclusion criteria were invited to the coordinating center in the university hospital. During the visit, they were interviewed using detailed questionnaires adopted from the EUROASPIRE V study [10], which included: medical history, CV risk factors, education, socioeconomic status, participation in cardiac rehabilitation programs, and pharmacotherapy. During the visit, BP (mean of at least two results) and heart rate were recorded, transthoracic echocardiography was performed, anthropometric measurements such as waist circumference (WC), weight, and height were taken, and blood samples were collected for laboratory tests such as blood count, lipidogram, glucose, creatinine, transaminases, creatine phosphokinase (CPK), C-reactive protein (CRP), N-terminal pro-B-type natriuretic peptide (NT-proBNP), glycated hemoglobin (HbA1c), and urine samples were taken for the determination of albumin/creatinine ratio. Glomerular filtration rate (GFR) was calculated using the Modification of Diet in Renal Disease (MDRD) formula. In patients without diagnosed DM oral glucose load tests were performed.

Height and weight were recorded in lightweight clothing without shoes using an SECA 701 scale and a model 220 growth meter. BP was measured using an Omron M6 automatic sphygmomanometer. WC was measured with a tape, midway between the lower edge of the rib arch and the upper iliac crest at the axillary midline in the standing position. Blood samples were collected after overnight fasting. Total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG) were analyzed in serum and HbA1c in venous blood. Low-density lipoprotein cholesterol (LDL-C) was calculated according to the Friedewald formula. The non-HDL-C cholesterol concentration was calculated by subtracting the HDL-C value from the TC value.

Transthoracic echocardiography was performed according to the guidelines of the American Society of Echocardiography and the European Association for Cardiovascular Imaging [11, 12]. Left ventricular ejection fraction (EF) was assessed by Simpson's method. Echocardiographic features of left ventricular hypertrophy (LVH) were diagnosed when the left ventricular mass index (LVMI) was ≥ 115 g/m^2 in men and ≥ 95 g/m^2 in women. Left ventricular diastolic dysfunction (LVDD) was diagnosed a priori in subjects with EF < 50% and in those with EF ≥ 50% when > 2 out of 5 following parameters met the specified values: septal mitral annular e' wave velocity (e'septal) < 7 cm/s, lateral mitral annular e' wave velocity (e'lateral) < 10 cm/s, the quotient of early mitral inflow wave velocity and averaged early diastolic mitral annular velocity measured by Doppler echocardiography (E/e') > 14, tricuspid regurgitation velocity (TRV) > 2.8 m/s, left atrial volume index (LAVI) > 34 mL/m^2. The analysis excluded patients with at least moderate mitral regurgitation, any mitral valve stenosis, significant mitral annular calcification, atrial fibrillation, left bundle branch block and paced rhythm.

Study patients were considered hypertensive if AH was diagnosed before the follow-up visit based on information obtained from medical records or information card from the time of index-hospitalization. The same procedure was followed for dyslipidemia and renal disease. The diagnosis of DM was established on the basis of previous diagnosis or current glucose metabolism determined at the follow-up visit after an oral glucose load test, according to standard criteria. Smoking was assessed based on the interview conducted at the follow-up visit. The presence of overweight and obesity was defined as body mass index (BMI) ≥ 25 and < 30 kg/m^2 and ≥ 30 kg/m^2, respectively, based on measurements taken at the follow-up visit. The presence of depression and anxiety was assessed using the Hospital Anxiety and Depression Scale questionnaire, with a score lower than 8 points considered normal, 8–10 points borderline, and 11–21 points implying the diagnosis of depression or anxiety.

The definitions of risk factors and therapeutic goals were based on the 2016 European Society of Cardiology guidelines for cardiovascular prevention in clinical practice [13]. According to the guidelines, the following targets were defined: controlled diabetes: HbA1c < 7.0%; primary dyslipidemia treatment target: LDL-C < 70 mg/dL or reduction of its values by at least 50% if they were between 70 and 135 mg/dL at baseline; secondary dyslipidemia treatment target: non-HDL-C < 100 mg/dL; SBP < 140 mm Hg; DBP < 90 mm Hg, except in diabetic patients, for whom the target DPB was < 85 mm Hg; BMI: 20.0–25.0 kg/m^2; normal WC: women < 80 cm, men < 94 cm; no smoking and regular physical activity equivalent to the moderate exercise of ≥ 150 minutes per week or vigorous exercise of ≥ 75 minutes per week.

Because baseline LDL-C measurements were unavailable for a large fraction of patients making the assessment of LDL-C reduction impossible, a concentration of < 70 mg/dL was adopted as a target LDL-C level. Normal values considered for other lipids were: TC < 190 mg/dL, HDL-C < 40 mg/dL in men and < 45 mg/dL in women, TG < 150 mg/dL, and non-HDL-C < 100 mg/dL. In the case of the NT-proBNP the concentration of < 125 pg/mL was taken as normal.

Body mass reduction achieved in the post-discharged period was assessed in patients with BMI ≥ 30 kg/m^2 at the time of hospitalization. The respective treatment goal was defined as target BMI < 30 kg/m^2 in subjects with initial BMI between 30 and 35 kg/m^2 or target BMI < 35 kg/m^2 in subjects with initial BMI ≥ 35 kg/m^2.

Statistical analysis

For descriptive statistics, the significance of results was inferred based on the two-sided Student's *t*-test for variables with a normal distribution (obtaining p > 0.05 values in the Shapiro-Wilk test) or the Wilcoxon test in other cases. The chi-square test was used for categorical variables. Analyses were performed using the "stats" package of the R program, version 3.6.3.

Results

180 subjects were enrolled in the study, including 49 women (27%) and 131 men (73%). AH was diagnosed in 88% of women (W) and 81% of men (M) (p = 0.56), resulting in a group of 149 individuals, of whom 29% were women, included in the analysis. The general characteristics of hypertensive patients is shown in Tables 1 and 2.

Among patients with AH, women were older than men (age 69 vs. 64 years, respectively; p< 0.001). There was an apparent male predominance in the group under

Table 1. General characteristics of the group of men and women with coronary artery disease and arterial hypertension

Parameter	Women, N [%]	Men, N [%]	p
Number of patients	43	106	
Mean age (SD)	69 (7)	64 (8)	< 0.001
Age ≥ 65	30 (70)	48 (45)	0.011
Incident:			0.74
• elective CABG	3 (7)	8 (8)	
• elective PCI	23 (53)	47 (44)	
• STEMI	1 (2)	7 (7)	
• NSTEMI	5 (12)	11 (10)	
• UA	11 (26)	33 (31)	
• History of ACS/ /CABG/PCI	26 (60)	68 (64)	0.81
Kidney disease	6 (14)	6 (6)	0.17
GFR < 60 mL/min	23 (53)	19 (19)	< 0.001
Albuminuria	12 (31)	20 (21)	0.28
Diabetes mellitus	19 (44)	47 (45)	1
Dyslipidemia	39 (91)	89 (84)	0.42
Overweight	12 (29)	50 (48)	0.048
Obesity	20 (48)	41 (39)	0.47
Central obesity	38 (88)	92 (91)	0.84
Active smoking	4 (13)	20 (23)	0.40
History of stroke	9 (21)	4 (4)	0.0023
Intervention due to lower limb arteriosclerosis	4 (9)	5 (5)	0.49
Hospitalization due to heart failure	8 (19)	14 (13)	0.56

ACS — acute coronary syndrome; CABG — coronary artery bypass surgery; GFR — glomerular filtration rate; NSTEMI — non-ST segment elevation myocardial infarction; PCI — elective coronary angioplasty; SD — standard disease; STEMI — ST-segment elevation myocardial infarction; UA — unstable coronary artery disease

Table 2. Comparison of psychosocial factors in men and women with coronary artery disease and arterial hypertension

Parameter	Women, N [%]	Men, N [%]	p
Anxiety level:			0.13
• low	27 (64)	78 (77)	
• borderline	7 (17)	15 (15)	
• high	8 (19)	8 (8)	
Depression:			0.56
• no	33 (78)	75 (74)	
• borderline	5 (12)	19 (19)	
• yes	4 (10)	7 (7)	
Education:			0.19
• high school	6 (14)	26 (25)	
• secondary school	26 (60)	48 (45)	
• below-secondary	11 (26)	32 (30)	
Employed/working	8 (19)	47 (44)	0.0057
Income:			0.51
• very low and low	16 (37)	29 (28)	
• medium	26 (60)	73 (70)	
• high	1 (2)	3 (2)	
Marital status:			< 0.001
• married	22 (51)	86 (82)	
• divorced/widow/ /widower/single	21 (49)	19 (18)	

65 years of age, and a female predominance in the group over 65 years of age.

Based on medical records from the time of hospitalization, there was no statistically significant gender-related difference in the frequency of kidney disease diagnoses (14% W vs. 6% M, p = 0.17). In laboratory tests performed during the follow-up visit, however, women were more likely than men to have a reduced GFR < 60 mL/min (53% W vs. 19% M, p < 0.001), yet with no significant difference in the frequency of albuminuria (31% W vs. 20% M, p = 0.28).

The occurrence of DM (44% W vs. 45% M, p = 1.00), dyslipidemia (91% W vs. 84% M, p = 0.42) and obesity (48% W vs. 39% M, p = 0.47) did not differ significantly between groups. Only 7% of women and 3% of men achieved weight reduction between index-hospitalization and follow-up visit (p = 0.79) (Table 3).

Considerably more women than men experienced stroke (21% W vs. 4% M, p < 0.001). There was no significant difference between groups in the rate of revascularization for lower limb atherosclerosis (9% W vs. 5% M, p = 0.49) or hospitalization for heart failure (19% W vs. 13% M, p = 0.56). Cigarettes were smoked by 13% of women and 23% of men (p = 0.40).

Table 3. Achievement of therapeutic goals in a group of women and men with arterial hypertension and coronary artery disease

Parameter	Women, N [%]	Men, N [%]	p
Blood pressure	21 (49)	52 (50)	1
Physical activity	11 (26)	31 (29)	0.80
Weight reduction	2 (7)	3 (3)	0.79
Smoking cessation	5 (56)	10 (34)	0.46
HbA1c	7 (37)	15 (32)	0.92
LDL-C	28 (35)	45 (56)	0.029
Non-HDL-C	28 (35)	43 (57)	0.022

HbA1c — glycated hemoglobin; LDL-C — low-density lipoprotein cholesterol; non-HDL-C — non-high--density lipoprotein cholesterol

Men were more often employed (19% W vs. 44% M, p = 0.0057) and more frequently declared being in a relationship (51% W vs. 82% M, p < 0.001).

At the follow-up visit, above normal LDL-C (p = 0.029) and non-HDL-C levels (p = 0.022) were more frequently recorded in women, which was reflected by significantly higher mean LDL-C (p = 0.014), TC (p < 0.001), and non--HDL-C (p = 0.01) concentrations (Table 4).

Concerning the echocardiographic findings, mean left ventricular EF was 57% in women and 54% in men (p = 0.10). Features of LVH and abnormal LAVI were found similarly frequent in both genders (LVH in 39% of women and 31% of men, p = 0.54; abnormal LAVI in 80% of women and 75% of men, p = 0.70). In contrast, features of LVDD were observed more often in women than in men (60% W vs. 55% M, p = 0.006) (Table 5).

The prevalence of elevated NT-proBNP concentrations was not markedly different between the entire groups (79% W vs. 64% M, p = 0.11), nor within subgroups having normal GFR together with coexisting: EF ≥ 50% (p = 0.45), LVH (p = 1.00) or LVDD (p = 0.78) (Table 5).

During the control visit, no significant gender-related differences were recorded with respect to mean SBP and DBP values. Mean SBP in women < 65 years of age was 141.1 mm Hg and in the group ≥ 65 years of age it was 138.0 mm Hg, while in men the respective values were 136.1 and 137.5 mm Hg (Table 6). Notably, 51% of women and 50% of men did not reach BP targets (p = 1.00) (Table 3). Among those patients mean SBP values were 156.7 and 151.0 mm Hg (p = 0.14) in women and men, respectively, and DBP were 83.3 and 89.3 mm Hg (p = 0.02), respectively.

81% of subjects confirmed being informed that they had AH, and 92% of this group (93% of women and 89% of men, p = 0.71) declared monitoring BP values. 51% claimed to know the BP targets, however, only 39% of women and 25% of men (p = 0.33) correctly indicated the upper target SBP value, and 16% of women and 12% of men (p = 0.69) correctly reported the upper target DBP value (Table 7).

Table 4. Comparison of lipidogram in men and women with with arterial hypertension and coronary artery disease

Women	Men	p	Women	Men	p
	LDL-C [mg/dL] (SD)			LDL-C ≥ 70 [mg/dL]	
85.9 (32.7)	72.3 (29.2)	0.014	28 (65)	45 (44)	0.029
	TC [mg/dL] (SD)			TC ≥ 190 [mg/dL]	
172.5 (36.5)	146.3 (36.9)	< 0.001	10 (23)	10 (10)	0.056
	HDL-C [mg/dL] (SD)			HDL-C < 40 [mg/dL] (men) < 45 mg/dl (women)	
57.6 (18.0)	48.4 (13.2)	0.0034	16 (37)	30 (29)	0.45
	TG [mg/dL] (SD)			TG ≥ 150 [mg/dL]	
145.6 (70.1)	134.0 (77.2)	0.088	13 (30)	29 (28)	0.96
	non-HDL-C [mg/dL] (SD)			non-HDL-C ≥ 100 [mg/dL]	
114.9 (37.4)	97.9 (35.6)	0.010	28 (65)	43 (43)	0.022

HDL-C — high-density lipoprotein cholesterol; LDL-C — low-density lipoprotein cholesterol; SD — standard disease; TC — total cholesterol

Table 5. Comparison of echocardiographic parameters and N-terminal pro-B-type natriuretic peptide (NT-proBNP) concentrations in men and women with arterial hypertension and coronary artery disease at the follow-up visit

Parameter	Women, N [%]	Men, N [%]	p
EF [%] (SD)	57 (9)	54 (10)	0.10
LVH	13 (39)	26 (31)	0.54
LAVI	32 (80)	76 (75)	0.70
LVDD	26 (60)	58 (55)	0.006
NT-proBNP ≥ 125 pg/mL	34 (79)	68 (64)	0.11
NT-proBNP ≥ 125 pg/mL, GFR > 60 mL/min and:			
• EF ≥ 50%	10 (59)	25 (45)	0.45
• LVH	5 (83)	15 (79)	1.00
• LVDD	4 (50)	8 (67)	0.78

EF — ejection fraction; GFR — glomerular filtration rate; LAVI — left atrial volume index; LVDD — left ventricular diastolic dysfunction; LVH — left ventricular hypertrophy; SD — standard disease

Women and men were equally likely to be administered all hypotensive drug groups (Table 8), with 95% of women and 92% of men receiving medications from the beta-blocker group, 90% of women and 84% of men receiving angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor antagonists, 37% of women and 27% of men taking calcium channel antagonists, and 60% of women and 52% of men diuretics, including 14% of women and 6% of men who were taking mineralocorticoid receptor antagonists (p = 0. 096).

Discussion

In the analyzed group, AH was diagnosed in 88% of women (mean age 69 years) and 81% of men (mean age 64 years). Accordingly, the prevalence of AH was higher than recorded in a 2005 study involving patients with CAD, in which AH was diagnosed in 70% of participants [14]. Likewise, in the NATPOL study AH was diagnosed in 32% of the Polish population, and specifically in 57% of subjects aged ≥ 60–79 years. Moreover, in the PolSenior study [15], conducted on a group of people aged ≥ 65 years, it was diagnosed in 76% of cases. Thus, AH in the discussed group appeared to be more frequent than in the above-mentioned studies, which could be due to several reasons. First, the mean age of the study participants was over 60 years, while it is known that the prevalence of AH increases with age. Another reason could be that AH is one of the major risk factors for CAD, and consequently, its prevalence in CAD patients is higher than in the general population. Yet

Table 6. Comparison of blood pressure values in women and men with diagnosed arterial hypertension and coronary artery disease at the time of hospitalization and follow-up visit

Parameter	Mean BP value in mm Hg (SD)		Number		p
	Women	Men	Women	Men	
Hospitalization					
SBP, the whole group	131.5 (26.6)	133.0 (25.3)	43	106	0.75
DBP, the whole group	76.7 (15.4)	79.3 (17.2)	43	106	0.36
SBP, age ≥ 65 years	135.9 (17.9)	135.2 (15.6)	30	50	0.87
DBP, age ≥ 65 years	77.1 (10.1)	80.1 (10.2)	30	50	0.19
SBP, age < 65 years	121.4 (39.3)	131.0 (31.6)	13	56	0.42
DBP, age < 65 years	75.8 (24.2)	78.6 (21.8)	13	56	0.69
Follow-up					
SBP, the whole group	138.9 (22.6)	136.7 (20.9)	43	105	0.45
DBP, the whole group	78.8 (11.6)	82.4 (11.3)	43	105	0.065
SBP, age ≥ 65 years	138.0 (23.8)	137.5 (18.9)	30	47	0.62
DBP, age ≥ 65 years	76.7 (12.2)	79.5 (10.1)	30	47	0.24
SBP, age < 65 years	141.1 (20.2)	136.1 (22.5)	13	58	0.52
DBP, age < 65 years	83.8 (8.4)	84.7 (11.7)	13	58	0.49
SBP, no BP goal achievement	156.7 (12.3)	151.0 (16.8)	22	53	0.14
DBP, no BP goal achievement	83.3 (11.7)	89.3 (8.9)	22	53	0.021
SBP, BP goal achievement	120.3 (14.0)	122.1 (13.0)	21	52	0.66
DBP, BP goal achievement	74.1 (9.6)	75.3 (8.7)	21	52	0.63

BP — blood pressure; DBP — diastolic blood pressure; SBP — systolic blood pressure; SD — standard disease

Table 7. The extent of knowledge about hypertension

Variable	Women, N [%]	Men, N [%]	p
Informed about AH	35 (81)	86 (81)	0.30
Monitors BP	40 (93)	93 (89)	0.71
Declares knowing target BP	23 (53)	52 (49)	0.24
Knows target SBP	9 (39)	13 (25)	0.33
Knows target DBP	7 (16)	13 (12)	0.69

AH — arterial hypertension; BP — blood pressure; DBP — diastolic blood pressure; SBP — systolic blood pressure

Table 8. Hypotensive drugs used in women and men at the follow-up visit

Drug group	Women, N [%]	Men, N [%]	p
Beta-blockers	41 (95)	97 (92)	0.64
ACE-inhibitors	29 (67)	76 (72)	0.75
Sartans	10 (23)	13 (12)	0.15
Diuretics	26 (60)	55 (52)	0.44
Calcium antagonists	16 (37)	29 (27)	0.32
Other hypotensive drugs	1 (2)	6 (6)	0.66

ACE — angiotensin-converting enzyme

another reason may be a tendency to falsely assign AH diagnosis in the situation of prescribing hypotensive drugs for other reasons, including CAD.

In our study, as many as half of the hypertensive patients had above normal BP values during the follow-up visit. This percentage was slightly higher than in the EUROASPIRE V study [10] in which 46% of participants receiving hypotensive drugs had BP higher than recommended at the follow-up visit. On the other hand, it was lower than that found in the NATPOL or WOBASZ II studies, in which as many as 73% of individuals did not achieve target BP values. The percentage of subjects with abnormal BP values was also lower than in the previously mentioned 2005 study conducted in CAD patients, in which 69% of participants had abnormal BP values. This may indicate an improvement in the efficacy of hypotensive treatment in CAD patients, which is in line with observations concerning the general population [2].

Meta-analyses have unequivocally shown that lowering systolic as well as diastolic BP per se is associated with a significant reduction in the incidence rate of all serious CV events and overall mortality [7, 8]. Recent studies have confirmed that these observations also apply to patients with stage 1 hypertension [16, 17], the elderly [18], and, in the case of CAD patients, to individuals with high normal BP in whom lowering BP was associated with a reduction in major CV incidents but had no effect on mortality [19]. Moreover, in the meta-analysis by D. Ettehad et al [7], as well as the meta-analysis of the ONTARGET and TRANSCED trials [20] it was found that the greatest benefit in most patients is achieved by lowering SBP to 120–130 mm Hg and DBP to 70–80 mm Hg.

In the light of these reports, the recent 2018 European Society of Cardiology/European Society of Hypertension (ESC/ESH) guidelines for the management of hypertension [21] indicated that hypotensive treatment can be considered in very high CV risk patients, particularly those with CAD, already in the presence of high normal BP [19]. These guidelines also recommend lowering BP targets in most patients taking hypotensive drugs: SBP to 120–129 mm Hg in age group < 65 years, and to 130–139 mm Hg in age group ≥ 65 years old, while DBP to a value of 70–79 mm Hg, regardless of the level of risk and associated diseases.

Regrettably, in the analyzed group, which should remain under more intensive control of CVD risk factors due to the history of ACS or coronary intervention, as many as half of the patients had SBP values > 150 mm Hg at the follow-up visit. Moreover, in the group of women < 65 years of age, the mean SBP value exceeded the upper limit of 140 mm Hg norm.

A high proportion of study patients had subclinical organ complications and comorbidities, with more frequent history of stroke and reduced GFR in women. GFR is the best available marker of kidney function, and the persistence of its lowered values for more than 3 months allows the diagnosis of CKD. AH is the second, after DM, cause of CKD development and progression, which additionally increases the risk of premature death, largely due to CVD [6]. LVDD was more frequently registered in women, and its presence is also associated with higher total mortality and more frequent hospitalizations for heart failure [22]. It is also worth emphasizing that the majority of patients, despite the declaration of BP monitoring, did not know the appropriate target BP values.

There was no gender-related difference in the type of pharmacotherapy administered to lower BP values, the choice of which was undoubtedly influenced by the presence of CAD. Both genders were equally likely to take drugs from all groups of hypotensive medications. This is of importance in the light of numerous studies conducted with ACE inhibitors (e.g. HOPE [23], PROGRESS [24], SMILE [25]), angiotensin II receptor antagonists (e.g. LIFE [26], VALUE [27], ONTARGET/TRANSCED [28, 29]) or calcium antagonists (e.g., ASCOT [30], VALUE), which demonstrated, that just lowering BP values, and not the type of drug used to do so, is the main determinant of risk reduction for CV complications.

The study has several limitations. First, it involves a strictly selected group of patients. Second, BP control was assessed based on measurements taken at the time of the follow-up visit rather than 24-hour ambulatory or home BP monitoring. On the one hand, this might have led to BP overestimation as a consequence of the white coat reaction, but on the other hand, it might have also contributed to its underestimation in cases of masked hypertension. Due to the lack of creatinine level measurements 3 months before the follow-up visit, it was impossible to diagnose chronic kidney failure.

Conclusions

The prevalence of AH in high-risk CV patients is high. In addition, a large proportion of patients with CAD do not achieve BP targets recommended by the guidelines. No significant gender-related differences were found in this regard. Targeted educational programs are needed to increase the awareness of CVD risk factors and improve the effectiveness of hypertension treatment.

Conflict of interest

None declared.

Funding

The study was neither funded nor supported by any external company or organization.

Streszczenie

Wstęp. Nadciśnienie tętnicze (AH) jest jednym z głównych, modyfikowalnych czynników ryzyka chorób układu sercowo-naczyniowego, który zwiększa zachorowalność i umieralność z powodu tych schorzeń.

Celem pracy była ocena rozpowszechnienia oraz kontrola leczenia AH u kobiet i mężczyzn z chorobą wieńcową.

Materiał i metody. Badanie przeprowadzono w grupie chorych włączonych do badania POLASPIRE w województwie mazowieckim. Definicje czynników ryzyka i celów terapeutycznych oparto na wytycznych Europejskiego Towarzystwa Kardiologicznego z 2016 roku dotyczących prewencji sercowo-naczyniowej.

Wyniki. AH rozpoznano u 88% kobiet i 81% mężczyzn (p = 0,56) włączonych do analizy. W grupie chorych z AH kobiety były starsze niż mężczyźni (p < 0,001). Częstości rozpoznawania cukrzycy (p = 1,00), dyslipidemii (p = 0,42) oraz otyłości (p = 0,47) nie różniły się istotnie pomiędzy grupami. U kobiet częściej stwierdzano przebyty udar mózgu (p < 0,001), obniżony współczynnik filtarcji kłębuszkowej (p < 0,001), podwyższone wartości cholesterolu frakcji lipoprotein o niskiej gęstości (p = 0,029), cholesterolu niezwiązanego z lipoproteinami o wysokiej gęstości (p = 0,022) oraz cechy dysfunkcji rozkurczowej lewej komory (p = 0,006). Docelowych wartości ciśnienia tętniczego nie osiągnęło 51% kobiet i 50% mężczyzn (p = 1,00). Nie stwierdzono istotnych różnic między grupami w zakresie farmakoterapii AH.

Wnioski. Rozpowszechnienie AH u osób z chorobą wieńcową jest duże. Wysoki odsetek chorych nie osiąga zalecanych wartości ciśnienia tętniczego. Konieczne jest podjęcie działań służących poprawie skuteczności leczenia hipotensyjnego.

Słowa kluczowe: nadciśnienie tętnicze, choroba wieńcowa, czynniki ryzyka, osiągnięcie celów terapeutycznych

Folia Cardiologica 2022; 17, 1: 11–19

References

1. Zdrojewski T, Rutkowski M, Bandosz P, et al. Ocena rozpowszechnienia i kontroli czynników ryzyka chorób serca i naczyń w Polsce — badania NATPOL 1997, 2002, 2011. Med Prakt. 2015: 57–64.
2. Niklas A, Flotyńska A, Puch-Walczak A, et al. WOBASZ II investigators. Prevalence, awareness, treatment and control of hypertension in the adult Polish population — Multi-center National Population Health Examination Surveys — WOBASZ studies. Arch Med Sci. 2018; 14(5): 951–961, doi: 10.5114/aoms.2017.72423, indexed in Pubmed: 30154875.
3. Hypertension. https://www.who.int/news-room/fact-sheets/detail/hypertension (August 5, 2021).
4. Forouzanfar MH, Liu P, Roth GA, et al. Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg, 1990–2015. JAMA. 2017; 317(2): 165–182, doi: 10.1001/jama.2016.19043, indexed in Pubmed: 28097354.
5. Rapsomaniki E, Timmis A, George J, et al. Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1·25 million people. Lancet. 2014; 383(9932): 1899–1911, doi: 10.1016/S0140-6736(14)60685-1, indexed in Pubmed: 24881994.
6. Webster AC, Nagler E, Morton R, et al. Chronic kidney disease. Lancet. 2017; 389(10075): 1238–1252, doi: 10.1016/s0140-6736(16)32064-5, indexed in Pubmed: 27887750.
7. Ettehad D, Emdin CA, Kiran A, et al. Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. Lancet. 2016; 387(10022): 957–967, doi: 10.1016/S0140-6736(15)01225-8, indexed in Pubmed: 26724178.
8. Thomopoulos C, Parati G, Zanchetti A. Effects of blood pressure lowering on outcome incidence in hypertension: 7. Effects of more vs. less intensive blood pressure lowering and different achieved blood pressure levels - updated overview and meta-analyses of randomized trials. J Hypertens. 2016; 34(4): 613–622, doi: 10.1097/HJH.0000000000000881, indexed in Pubmed: 26848994.
9. Jankowski P, Kosior DA, Sowa P, et al. Secondary prevention of coronary artery disease in Poland. Results from the POLASPIRE survey. Cardiol J. 2020; 27(5): 533–540, doi: 10.5603/CJ.a2020.0072, indexed in Pubmed: 32436589.
10. Kotseva K, De Backer G, De Bacquer D, et al. EUROASPIRE Investigators*. Lifestyle and impact on cardiovascular risk factor control in coronary patients across 27 countries: Results from the European Society of Cardiology ESC-EORP EUROASPIRE V registry. Eur J Prev Cardiol. 2019; 26(8): 824–835, doi: 10.1177/2047487318825350, indexed in Pubmed: 30739508.
11. Nagueh SF, Smiseth OA, Appleton CP, et al. Houston, Texas; Oslo, Norway; Phoenix, Arizona; Nashville, Tennessee; Hamilton, Ontario, Canada; Uppsala, Sweden; Ghent and Liège, Belgium; Cleveland, Ohio; Novara, Italy; Rochester, Minnesota; Bucharest, Romania; and St. Louis, Missouri. Recommendations for the evaluation of left ventricular diastolic function by echocardiography: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr. 2016; 29(4): 277–314, doi: 10.1016/j.echo.2016.01.011, indexed in Pubmed: 27037982.
12. Lang RM, Badano L, Mor-Avi V, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Eur Hear J — Cardiovasc Imaging. 2015; 16(3): 233–271, doi: 10.1093/ehjci/jev014.
13. Piepoli MF, Hoes A, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J. 2016; 37(29): 2315–2381, doi: 10.1093/eurheartj/ehw106, indexed in Pubmed: 27222591.

14. Jankowski P, Kawecka-Jaszcz K, Bilo G, et al. Determinants of poor hypertension management in patients with ischaemic heart disease. Blood Press. 2005; 14(5): 284–292, doi: 10.1080/08037050500239962, indexed in Pubmed: 16257874.
15. Zdrojewski T, Wizner B, Więcek A, et al. Prevalence, awareness, and control of hypertension in elderly and very elderly in Poland: results of a cross-sectional representative survey. J Hypertens. 2016; 34(3): 532–8; discussion 538, doi: 10.1097/HJH.0000000000000823, indexed in Pubmed: 26771343.
16. Lonn EM, Bosch J, López-Jaramillo P, et al. HOPE-3 Investigators. Blood-pressure lowering in intermediate-risk persons without cardiovascular disease. N Engl J Med. 2016; 374(21): 2009–2020, doi: 10.1056/NEJMoa1600175, indexed in Pubmed: 27041480.
17. Thomopoulos C, Parati G, Zanchetti A. Effects of blood pressure lowering on outcome incidence in hypertension. 1. Overview, meta-analyses, and meta-regression analyses of randomized trials. J Hypertens. 2014; 32(12): 2285–2295, doi: 10.1097/HJH.0000000000000378, indexed in Pubmed: 25255397.
18. Williamson JD, Supiano M, Applegate W, et al. Intensive vs standard blood pressure control and cardiovascular disease outcomes in adults aged ≥75 years. JAMA. 2016; 315(24): 2673, doi: 10.1001/jama.2016.7050.
19. Brunström M, Carlberg Bo. Association of blood pressure lowering with mortality and cardiovascular disease across blood pressure levels: a systematic review and meta-analysis. JAMA Intern Med. 2018; 178(1): 28–36, doi: 10.1001/jamainternmed.2017.6015, indexed in Pubmed: 29131895.
20. Böhm M, Schumacher H, Teo K, et al. Achieved diastolic blood pressure and pulse pressure at target systolic blood pressure (120–140 mmHg) and cardiovascular outcomes in high-risk patients: results from ONTARGET and TRANSCEND trials. Eur Heart J. 2018; 39(33): 3105–3114, doi: 10.1093/eurheartj/ehy287, indexed in Pubmed: 29873709.
21. Williams B, Mancia G, Spiering W, et al. List of authors/Task Force members:. 2018 Practice Guidelines for the management of arterial hypertension of the European Society of Hypertension and the European Society of Cardiology: ESH/ESC Task Force for the Management of Arterial Hypertension. J Hypertens. 2018; 36(12): 2284–2309, doi: 10.1097/HJH.0000000000001961, indexed in Pubmed: 30379783.
22. Nagueh SF. Left ventricular diastolic function: understanding pathophysiology, diagnosis, and prognosis with echocardiography. JACC Cardiovasc Imaging. 2020; 13(1 Pt 2): 228–244, doi: 10.1016/j.jcmg.2018.10.038, indexed in Pubmed: 30982669.
23. Yusuf S. The HOPE (Heart Outcomes Prevention Evaluation) study: the design of a large, simple randomized trial of an angiotensin-converting enzyme inhibitor (ramipril) and vitamin e in patients at high risk of cardiovascular events. Can J Cardiol. 1996; 12: 127–137.
24. Randomised trial of a perindopril-based blood-pressure-lowering regimen among 6105 individuals with previous stroke or transient ischaemic attack. Lancet. 2001; 358(9287): 1033–1041, doi: 10.1016/s0140-6736(01)06178-5.
25. Borghi C, Cicero AFG, Ambrosioni E. Effects of early treatment with zofenopril in patients with myocardial infarction and metabolic syndrome: the SMILE Study. Vasc Health Risk Manag. 2008; 4(3): 665–671, doi: 10.2147/vhrm.s2799, indexed in Pubmed: 18827916.
26. Dahlöf B, Devereux R, Kjeldsen S, et al. Cardiovascular morbidity and mortality in the Losartan Intervention For Endpoint reduction in hypertension study (LIFE): a randomised trial against atenolol. Lancet. 2002; 359(9311): 995–1003, doi: 10.1016/s0140-6736(02)08089-3.
27. Zanchetti A, Julius S, Kjeldsen S, et al. Outcomes in subgroups of hypertensive patients treated with regimens based on valsartan and amlodipine: An analysis of findings from the VALUE trial. J Hypertens. 2006; 24(11): 2163–2168, doi: 10.1097/01.hjh.0000249692.96488.46, indexed in Pubmed: 17053536.
28. Mancia G, Unger T, Zanchetti A. Introduction: Reducing cardiovascular risk: ONTARGET — a new standard in cardiovascular protection. J Hypertens Suppl. 2009; 27(5): S1, doi: 10.1097/01.hjh.0000357901.86327.d8, indexed in Pubmed: 19587549.
29. Böhm M, Schumacher H, Teo KK, et al. Achieved blood pressure and cardiovascular outcomes in high-risk patients: results from ONTARGET and TRANSCEND trials. Lancet. 2017; 389(10085): 2226–2237, doi: 10.1016/S0140-6736(17)30754-7, indexed in Pubmed: 28390695.
30. Gupta A, Mackay J, Whitehouse A, et al. Long-term mortality after blood pressure-lowering and lipid-lowering treatment in patients with hypertension in the Anglo-Scandinavian Cardiac Outcomes Trial (ASCOT) Legacy study: 16-year follow-up results of a randomised factorial trial. Lancet. 2018; 392(10153): 1127–1137, doi: 10.1016/S0140-6736(18)31776-8, indexed in Pubmed: 30158072.

REVIEW ARTICLE

Folia Cardiologica 2022
vol. 17, no. 1, pages 20–26
DOI: 10.5603/FC.2022.0004

ISSN 2353–7752
e-ISSN 2353–7760

The role of a clinical pharmacist in self-care in heart failure

Agnieszka Skotnicka[1], Anna Jabłecka[2]

[1]Chair and Department of Pharmaceutical Technology, *Collegium Chemicum*, Karol Marcinkowski University of Medical Sciences in Poznan, Poland

[2]Department of Clinical Pharmacology, Chair of Cardiology, Karol Marcinkowski University of Medical Sciences in Poznan, Poland

Abstract

Heart failure (HF) is a major health problem in the contemporary societies and one of the most common chronic syndromes, associated with high mortality and intensive healthcare resource use, both human and financial. Therapeutic strategies should include monitoring of the patients' health status since the hospital discharge, optimization of drug therapy, and modification of environmental factors. Self-care offers a significant strategic potential to relieve healthcare system in HF, allowing targeted resource transfer and potential increase of the healthcare system efficiency. Involving the clinical pharmacist in the process of self-care in regard to optimization of the drug treatment used, standardization of drug treatment during patient transfer between various areas of healthcare, clarification of recommendations regarding drug use, and professional counselling has significant consequences translating to an increased therapy effectiveness and healthcare resource utilisation. Promoting self-care in HF should be a strategic priority, and incorporation of self-care within the routine medical care for HF patients should be considered equally important to providing the patient with medications necessary to control this syndrome. This synergistic approach will result in a reduced readmission rate and an improved quality of life of patients with HF.

Key words: self-care, heart failure, pharmacist intervention

Folia Cardiologica 2022; 17, 1: 20–26

Introduction

Heart failure (HF) is a major health problem in the contemporary societies and one of the most common chronic syndromes, associated with high mortality and intensive healthcare resource use, both human and financial. The prevalence of this syndrome in developed countries is 1–2%, rising to at least 10% in those above 75 years of age, but it has been predicted that in the next years, HF will develop in as much as 20% of the population [1]. In the United States, it has been estimated that in 2010–2030, the prevalence of all cardiovascular disease will increase by 9.9%, while the prevalence of HF will increase by 25%, and due to increasing use of increasingly advanced and complex therapies, the cost of treatment of this patient group will increase by as much as 215% by 2030 [2]. Although mortality due to HF has decreased slightly, it remains high, up to 40% during the first year after the initial hospitalization, and in patients who are regularly and frequently hospitalized, especially during the first year after the initial hospitalization, it may be as high as 50% [3].

Heart failure is a clinical syndrome characterized by typical symptoms and signs, developing due to physiological alterations, such as water and electrolyte disturbances, constrictor function of the blood vessels, and myocardial overactivity. The key to effective control of HF is adequate drug therapy, although the European Society of Cardiology (ESC) and American Heart Association (AHA) guidelines highlight the need to supplement drug therapy with non-drug treatment strategies implemented by interdisciplinary

Address for correspondence: MSc in Pharm. Agnieszka Skotnicka, Uniwersytet Medyczny im. Karola Marcinkowskiego w Poznaniu, ul. Grunwaldzka 6, 60–780 Poznań, Poland, phone +48 61 854 66 84, e-mail: askotnic@ump.edu.pl

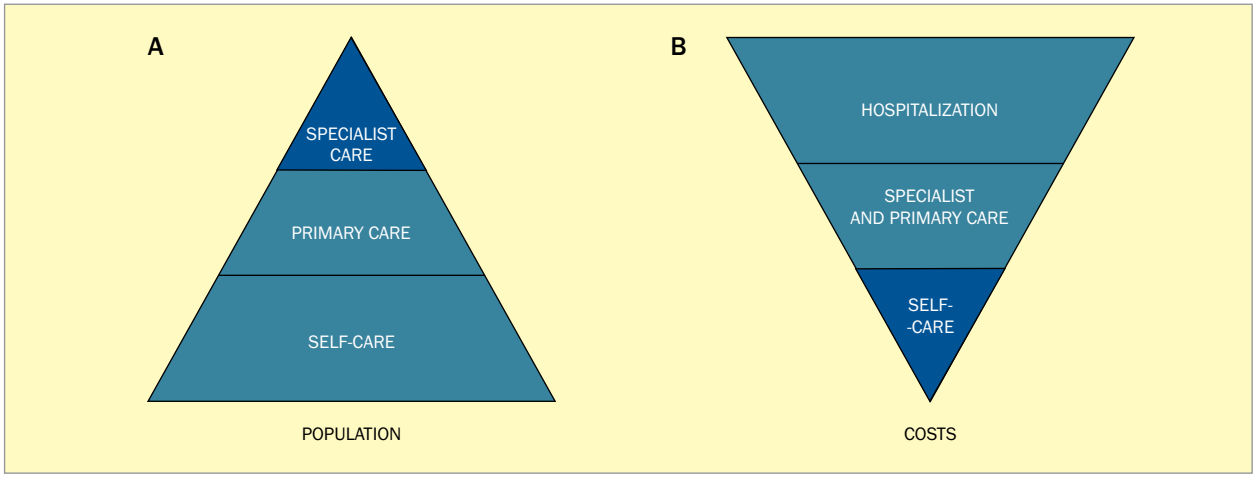


Figure 1A, B. The pyramid of self-care (based on [13])

specialist teams with patient involvement. These therapeutic strategies should include monitoring of the patients' health status since the hospital discharge, education, and optimizing drug therapy in response to HF worsening [4].

Self-care

The currently widely employed traditional healthcare model does not guarantee constant supervision of every patient by a physician or a nurse. Constant care and control is not only not feasible in the state-managed healthcare but also unnecessary in case of one-off interventions, such as pacemaker implantation, where long-term cooperation with the patient is not pursued, and the patient has no effect on the effectiveness of the device functioning [5]. In most patients with HF, initiation of systematic and long-term cooperation is necessary, and the more informed is this cooperation, the better are the treatment outcomes. Clearly, lack of medication adherence contributes to disease progression. Thus, all recommendations regarding modifiable risk factors such as diet, physical activity, and drug therapy should be provided using an effective, patient-adjusted communication, taking into account that implementation of these recommendations is associated with some discomfort and requires some sacrifices and effort from the patient. An appropriate message that includes estimates of benefits and risk is a prerequisite of patient cooperation. Informed patients who trust the content and purpose of therapeutic recommendations may positively affect their own wellbeing and treatment outcomes [6].

Thus, in response to clinical guidelines and technological advances, healthcare systems all over the world must evolve to maintain their economic and infrastructural efficiency [7]. Interventions to maintain the efficiency of healthcare systems focus on the achievement of rational savings, for example by reducing the number of hospitalizations that generate a substantial part of costs of care for HF patients, amounting to as much as 70% of the total cost of treating this syndrome [8]. It is known that the proportion of preventable event and hospitalization is high [9, 10]. As costs related to recurrent or long-lasting hospitalizations due to disease worsening [10] are mostly secondary to inadequate patient awareness and self-care [11], the current direction of healthcare system evolution is to increase the patient engagement in care, away from the traditional healthcare model with only inertial patient participation in the treatment process (Figure 1) [12, 13]. It has been confirmed that the costs of care for informed and involved patients who make autonomous decisions regarding the control of their own health status are 8–20% lower compared to inert patients [14].

The most common causes of hospitalization in patients with HF result from a delayed or absent patient response to worsening of chronic HF control, low adherence, and lacking self-care skills [15, 16]. Worsening of HF and avoidable hospitalizations are clearly related to self-care failures [11] and thus increasing the efficiency of this core component of healthcare has a fundamental role in stabilizing the health status, optimizing treatment effects and improving patients' quality of life [17]. The prognosis in HF depends on two factors: one is the choice of drug therapies made by the physician, and the other one is patient-dependent and self-care-based, including the motivation to adhere to the diagnostic and therapeutic recommendations [4].

Self-care is a set of autonomous actions of a disease-conscious patient, self-initiated to achieve and maintain an appropriate health status. These are mostly preventive actions related to healthy lifestyle, along with participation in the therapy [13]. Self-care delays development of disease complications and allows control and coping with incident

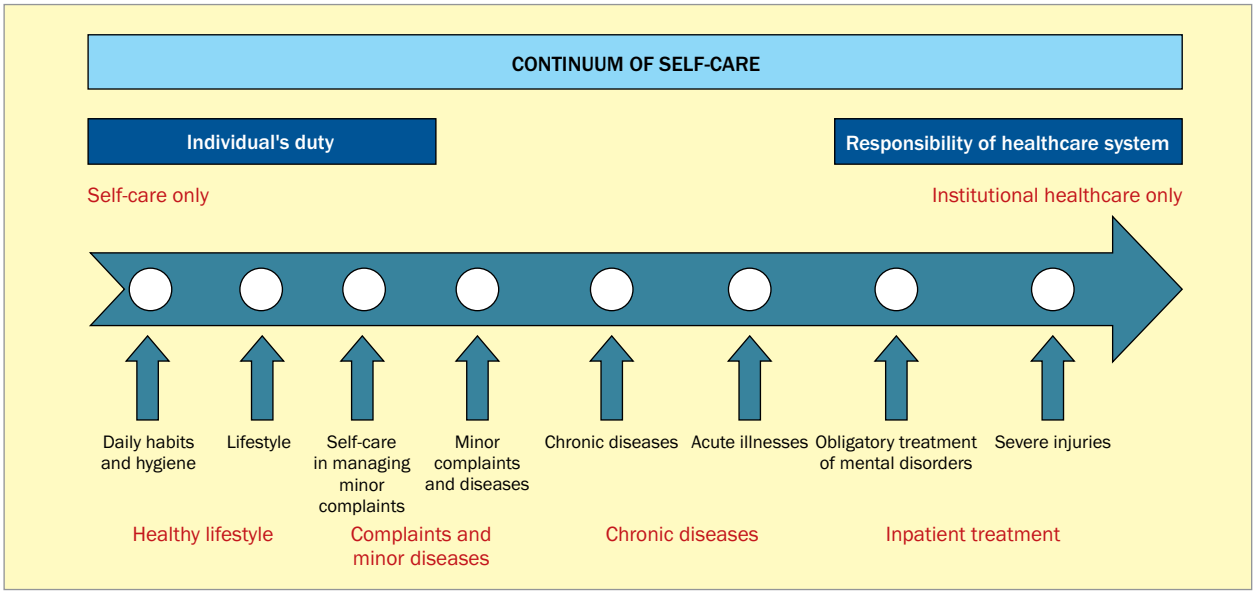


Figure 2. Continuum of self-care (based on [18])

symptoms. In general, self-care includes modification and control of such factors as environmental factors, socioeconomic factors, and medication self-administration. The latter is of particular importance both regarding the patient's own choice of medications and the way these medications are using in the framework of a responsible and informed management process. Self-care is a continuum (Figure 2) that includes both a number of actions undertaken directly and exclusively by the patient who is fully responsible for these actions, such as decision-making regarding daily activities, and managing common complaints, including seasonal ones, and on the other hand, also the complex management of acute and chronic diseases undertaken by specialized healthcare institutions [18].

The aim of self-care in HF is to develop and use skills related to non-drug support and regular self-monitoring of the patient's health status [4]. The most important components of control may be defined as recognition of symptoms and significant changes in their severity, along with the ability to decide, based on self-observation, that a specialist should be contacted.

The most important self-care actions that may improve prognosis in HF include self-education regarding the HF syndrome, adherence to the therapeutic and dietary recommendations, active participation in symptom monitoring and the ability to interpret symptoms that indicate HF control worsening, the ability to act at an early stage of health status deterioration, regular physical activity, control of substance use, and the management of concomitant conditions [16]. Implementation of dietary recommendations and monitoring such parameters as blood pressure and body weight significantly improve outcomes [19, 20], and persistence in self-care reduces hospitalizations, readmissions [21] and mortality [22] and improves patients' quality of life [23].

A stimulus and a prerequisite for popularization and spread of self-care is the increasing accessibility of medical information through the development of internet resources, increased drug availability, lifestyle changes, and a growing population potential for participation in the management process. The level of education and interest in the society continues to grow, all resulting in a higher patient participation in the treatment process. The extent of health awareness along with the ability and willingness to acquire information about the disease and its symptoms, but also limited access to physicians and clinics are additional stimuli for promulgating self-care. With self-care, patients may take some responsibility for their health, and governments may modify the mechanism of resource freeing in the context of increasing healthcare system overload in terms of both costs and infrastructural efficiency of the aging societies.

Initiation and implementation of healthcare is based on an adequate level of health literacy which also guarantees that the received information and therapeutic recommendations will allow informed decisions and actions [11].

The key prerequisite for patient compliance with the therapeutic recommendations is their understanding by the patient. All over the world, HF patients have or may have difficulties with comprehending the recommendations regarding drug therapy, particularly in case of complex treatment regimens, and with implementing lifestyle modification. To effectively adjust the way recommendations are communicated, the individual functional health literacy must be

determined, which includes the ability to read, write, and calculate at a level adequate for daily needs, and motivation and skills regarding accessing, understanding, evaluating and using health information for daily decision making [24]. Determining the level of patient's literacy allows creation and selection of appropriate informational materials, such as medication package inserts, posters, and educational campaigns. Unfortunately, a large proportion of patients do not understand and thus do not adhere to basic recommendations regarding self-care based on the written materials provided, only one in two patients read the recommendations correctly, and one in three patients do not understand the sense of the recommendation to take a medication on an empty stomach (i.e., fasting) [24]. As it has been shown that a higher level of health literacy increases compliance with the recommendations, improving health literacy is a strategic goal for the healthcare system and specialists, such as physicians, pharmacists, nurses and dieticians, and organizations involved in education and implementation of prevention programs.

Patients at a low level of health literacy have major problems with processing and acquisition of information regarding their health status, interpretation of the symptoms, and comprehending oral communications provided by a cardiologist or other physician. They are also 1.5 to 3 times more likely to develop adverse health outcomes [18]. An analysis of the study results published so far indicates that among hospitalized HF patients, health literacy is inadequate in 42% and marginal in 19% [25].

Lack of elementary knowledge on HF and self-care is a widespread phenomenon among both patients and their careers. Multiple studies showed that a low patient ability to engage in self-care in HF is associated with a generally low level of education and little knowledge on self-care. The identified areas of insufficient patient competencies include limitation of salt intake, compliance with the recommendations regarding the use of medication, body weight control, and physical activity. Lack of knowledge contributes to disorientation, delays in seeking help, uncertainty regarding the future, and inability to provide self-care. To increase benefits from actions undertaken by HF patients, it is necessary to regularly examine the level of the ability to solve problems and execute actions [26].

The main barriers to understanding the therapeutic recommendations include a complex healthcare system, lack of the sense of sufficient competence when making autonomous treatment decisions, specialized language of informational materials, and lacking communication skills by the healthcare personnel. Patients have indicated a lack of experience in self-observation and decision-making [16]. Obvious limitations for increasing patient participation in the therapy include impaired cognitive

Table 1. Barriers to the provision of self-care in heart failure (HF) and the proposed strategies and interventions

Barrier	Strategy	Intervention
Functional abilities and vision and hearing impairment	Evaluation of the degree of impairment Adjustment of informational materials and communication methods used	Use of teaching aids in the form of ergonomic mobile devices appropriate for the elderly patients, with large keys, fonts, and illustrations
Cognitive dysfunction, dementia	Use of tools and methods appropriate for the patient, communication with a high degree of information reiteration, dividing the message into absorbable portions, involving the direct patient carer in the education process	Interactive educational tools Brief informational materials, e.g. leaflets Multiple reiteration
Erroneous beliefs and lack of basic knowledge of the disease	Analysis of the cause(s) of erroneous beliefs and of the level of patient knowledge of the disease	Basic education regarding the disease and its treatment
Low level of motivation and interest in the treatment process	Adjustment to the patient's needs Thoughtful and constructive education	Evaluation of the patient's needs and expectations regarding the level of knowledge Holistic care Consideration of depression and fatigue
Low self-esteem and lack of belief in one's own capabilities	Materials and methods free from the elements of threat and punishment Positive motivating Support	Developing positive cooperation and interaction with the patient Education with elements of social support, e.g. teleadvice, home visits

function, concomitant depression which limits the ability of self-motivation, fear of autonomous execution of actions, and lack of social support [14]. Concomitant diseases, particularly in patients above 73 years of age, make it more difficult to correctly interpret and differentiate dyspnoea or fatigue. In addition, HF is rarely present as the sole clinical syndrome, as it is usually accompanied by other diseases affecting the number of symptoms requiring interpretation. On average, HF patients experience nine symptoms [27] that are non-specific and difficult to differentiate. A barrier to self-care is also the lack of physician acknowledgement of the effects of self-care, resulting in inadequate cooperation on the clinicians' side and their focus on drug therapy targets [14]. Clinicians question patient competencies, which significantly reduces the proportion of patients engaged in the process of supporting care [28].

Education in HF

Patients' level of knowledge about their HF is low, resulting in high rate of hospitalisation [29]. Increased level of knowledge and awarness to satisfactory level leads to health benefits such as reduction in re-hospitalisation [30].

Education regarding the knowledge on HF, its course and the consequences of non-compliance with the recommendations should be introduced at a basic level as early as possible, individually adjusted depending on the stage of disease acceptance, and the structure and order of providing the educational content should be consistent with the care plan. When improving health competencies, a challenge is to adjust educational materials to specific social groups, taking into account their cultural, gender, age, and other individual characteristics (Table 1) [31].

Education regarding self-care targeted at individuals at a low level of health literacy may improve the effectiveness of self-care and increase awareness of patients at risk of low effectiveness of HF therapy. Dissemination of self-care in HF requires an increased engagement of healthcare personnel that should be made aware of the potential of self-care and ways to promote it. An excellent strategy is to engage other healthcare personnel and to create multidisciplinary teams responsible for self-care [32] and education [33].

Direct contact with patients outside the stress-inducing clinical environment and the current revolution regarding traditional duties, and revolution in drug manufacturing all place the pharmacist in an ideal position for medical education and modification of health literacy [17]. Among various healthcare personnel, pharmacists are one of the best prepared for helping patients understand the treatment process. In the classical healthcare model, the role of pharmacist has mostly been to supply patients with proprietary medicinal products and compounded drugs. Over the last decades, however, this role has evolved towards increased participation in self-care.

Table 2. Overview of the education topics in heart failure

General counselling	Description of symptoms and complaints
	Aetiology
	Principles of health status monitoring
	Symptom self-control
	Body weight control
	Rationale for drug therapy
	Recommendations regarding medication use
	Prognosis
Professional advice regarding drug therapy	Medication effects, adverse effects, symptoms of toxicity
	Mode of drug administration
	Drug interactions (potential and avoidable)
	Diuretic use on the as-needed basis
Physical activity	Rest
	Systematic moderate physical activity
	Nature of professional activities
	Sexual activity
Diet and substances	Reduction of salt intake
	Reduction and control of fluid intake
	Avoidance of alcohol
	Quitting smoking
	Body weight-reducing diet
Vaccinations	Influenza
	Pneumococci
	SARS-CoV-2
Travel	Advice regarding flying
	Risk associated with tropical climate, high ambient humidity and temperature, and high altitudes with reduced air oxygen content

SARS-CoV-2 — severe acute respiratory syndrome coronavirus 2

The role of pharmacist in self-cares involves four areas: as a communicator, drug supplier, supervisor, and propagator. It is the pharmacist who initiates a dialogue with the patient, verifies the symptoms, and decides whether it is necessary to refer the patient to a physician. He supports the patient in the choice of drugs, guaranteeing their proper use based on the established rules of cooperation with other healthcare personnel. Clinical pharmacists provide advice at the time of hospital discharge, analyse the instituted drug treatment, and educate regarding new recommendations. At the level of a publicly available pharmacy,

they provide pharmaceutical care and offer counselling regarding minor complaints.

Pharmacist involvement in the above mentioned stages of the treatment process in HF patients improves adherences but these benefits disappear at 3 months after the discharge [34] which indicates the need for systematic efforts. Education provided by the pharmacist (Table 2) reduces all-cause and HF-related mortality [35] and lowers the readmission rate [34]. Pharmacist interventions also have an indirect economical dimension, as elimination of drug-related errors prevents the related costs [36]. HF patients receiving pharmaceutical care become more open in expressing their concerns or doubts, which allows to adjust the scope of education and eliminate barriers to self-care [37].

Involving the pharmacist in the delivery of self-care brings clinical benefits, improvement of the patients' quality of life, and benefits regarding healthcare management [38], increases adherence in HF [39], and reduces the rate of readmissions within the first 30 days after the discharge [35]. Involving the pharmacist in the process of self-care [40] in regard to optimization of the drug treatment used, standardization of drug treatment during patient transfer between various areas of healthcare, clarification of recommendations regarding drug use, and participation in diuretic use on the as-needed basis depending on the symptom severity has significant consequences translating to an increased effectiveness of drug therapy and healthcare resource utilisation.

Conclusions

Self-care offers a significant strategic potential to relieve healthcare system in HF, allowing targeted resource transfer to increase the contribution of modern and effective therapies, and thus potentially increase the efficiency of the healthcare system. Promoting self-care in HF should be a strategic priority, and incorporation of self-care within the routine medical care for HF patients should be considered equally important to providing the patient with medications necessary to control this syndrome. This synergistic approach will result in a reduced readmission rate and an improved quality of life of patients with HF.

Conflict of interest

None.

Funding

None.

References

1. Lloyd-Jones DM, Larson MG, Leip EP, et al. Framingham Heart Study. Lifetime risk for developing congestive heart failure: the Framingham Heart Study. Circulation. 2002; 106(24): 3068–3072, doi: 10.1161/01.cir.0000039105.49749.6f, indexed in Pubmed: 12473553.
2. Chen J, Normand SLT, Wang Y, et al. National and regional trends in heart failure hospitalization and mortality rates for Medicare beneficiaries, 1998-2008. JAMA. 2011; 306(15): 1669–1678, doi: 10.1001/jama.2011.1474, indexed in Pubmed: 22009099.
3. Howlett JG, Johnstone DE, Sketris I, et al. Improving Cardiovascular Outcomes in Nova Scotia investigators. Identifying opportunities to address the congestive heart failure burden: the Improving Cardiovascular Outcomes in Nova Scotia (ICONS) study. Can J Cardiol. 2003; 19(4): 439–444, indexed in Pubmed: 12704493.
4. Ponikowski P, Voors AA, Anker SD, et al. ESC Scientific Document Group. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016; 37(27): 2129–2200, doi: 10.1093/eurheartj/ehw128, indexed in Pubmed: 27206819.
5. Cleland JGF, Daubert JC, Erdmann E, et al. Longer-term effects of cardiac resynchronization therapy on mortality in heart failure [the CArdiac REsynchronization-Heart Failure (CARE-HF) trial extension phase]. Eur Heart J. 2006; 27(16): 1928–1932, doi: 10.1093/eurheartj/ehl099, indexed in Pubmed: 16782715.
6. Cleland JGF, Ekman I. Enlisting the help of the largest health care workforce--patients. JAMA. 2010; 304(12): 1383–1384, doi: 10.1001/jama.2010.1387, indexed in Pubmed: 20858885.
7. What do we mean by self care and why is it good for people? The self-care continuum. Self Care Forum. https://www.selfcareforum.org/about-us/what-do-we-mean-by-self-care-and-why-is-good-for-people/ (February 15, 2021).
8. Cleland JG, Swedberg K, Poole-Wilson PA. Successes and failures of current treatment of heart failure. Lancet. 1998; 352(Suppl 1): SI19–SI28, doi: 10.1016/s0140-6736(98)90015-0, indexed in Pubmed: 9736476.
9. Linné AB, Liedholm H, Jendteg S, et al. Health care costs of heart failure: results from a randomised study of patient education. Eur J Heart Fail. 2000; 2(3): 291–297, doi: 10.1016/s1388-9842(00)00089-1, indexed in Pubmed: 10938491.
10. Liao L, Anstrom KJ, Gottdiener JS, et al. Long-term costs and resource use in elderly participants with congestive heart failure in the Cardiovascular Health Study. Am Heart J. 2007; 153(2): 245–252, doi: 10.1016/j.ahj.2006.11.010, indexed in Pubmed: 17239685.
11. Formiga F, Chivite D, Manito N, et al. Hospitalization due to acute heart failure. Role of the precipitating factors. Int J Cardiol. 2007; 120(2): 237–241, doi: 10.1016/j.ijcard.2006.10.004, indexed in Pubmed: 17175043.
12. Self-care: a winning solution. Association of the European Self-Medication Industry. http://www.aesgp.eu/media/cms_page_media/68/Self-Care%20A%20Winning%20Solution.pdf (Accessed February 2021).
13. Bell J, Dziekan G, Pollack C, et al. Self-care in the twenty first century: a vital role for the pharmacist. Adv Ther. 2016; 33(10): 1691–1703, doi: 10.1007/s12325-016-0395-5, indexed in Pubmed: 27535290.

14. Health policy brief: patient engagement. Health affairs. http://www.healthaffairs.org/ healthpolicybriefs/ (February 15, 2021).
15. Riegel B, Moser DK, Anker SD, et al. American Heart Association Council on Cardiovascular Nursing, American Heart Association Council on Cardiovascular Nursing, American Heart Association Council on Clinical Cardiology, American Heart Association Council on Nutrition, Physical Activity, and Metabolism, American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research. State of the science: promoting self-care in persons with heart failure: a scientific statement from the American Heart Association. Circulation. 2009; 120(12): 1141–1163, doi: 10.1161/CIRCULATIONAHA.109.192628, indexed in Pubmed: 19720935.
16. Evangelista LS, Rasmusson KD, Laramee AS, et al. Health literacy and the patient with heart failure — implications for patient care and research: a consensus statement of the Heart Failure Society of America. J Card Fail. 2010; 16(1): 9–16, doi: 10.1016/j.cardfail.2009.10.026, indexed in Pubmed: 20123313.
17. Moser DK, Dickson V, Jaarsma T, et al. Role of self-care in the patient with heart failure. Curr Cardiol Rep. 2012; 14(3): 265–275, doi: 10.1007/s11886-012-0267-9, indexed in Pubmed: 22437374.
18. Dewalt DA, Berkman ND, Sheridan S, et al. Literacy and health outcomes: a systematic review of the literature. J Gen Intern Med. 2004; 19(12): 1228–1239, doi: 10.1111/j.1525-1497.2004.40153.x, indexed in Pubmed: 15610334.
19. Hammash MH, Crawford T, Shawler C, et al. Beyond social support: self-care confidence is key for adherence in patients with heart failure. Eur J Cardiovasc Nurs. 2017; 16(7): 632–637, doi: 10.1177/1474515117705939, indexed in Pubmed: 28443677.
20. Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation. 2013; 128(16): 1810–1852, doi: 10.1161/CIR.0b013e31829e8807, indexed in Pubmed: 23741057.
21. Jovicic A, Holroyd-Leduc JM, Straus SE. Effects of self-management intervention on health outcomes of patients with heart failure: a systematic review of randomized controlled trials. BMC Cardiovasc Disord. 2006; 6: 43, doi: 10.1186/1471-2261-6-43, indexed in Pubmed: 17081306.
22. Albert NM. Promoting self-care in heart failure: state of clinical practice based on the perspectives of healthcare systems and providers. J Cardiovasc Nurs. 2008; 23(3): 277–284, doi: 10.1097/01.JCN.0000305095.27635.4f, indexed in Pubmed: 18437070.
23. Jonkman NH, Westland H, Groenwold RHH, et al. Do self-management interventions work in patients with heart failure? An individual patient data meta-analysis. Circulation. 2016; 133(12): 1189–1198, doi: 10.1161/CIRCULATIONAHA.115.018006, indexed in Pubmed: 26873943.
24. McDonald HP, Garg AX, Haynes RB. Interventions to enhance patient adherence to medication prescriptions: scientific review. JAMA. 2002; 288(22): 2868–2879, doi: 10.1001/jama.288.22.2868, indexed in Pubmed: 12472329.
25. Dennison CR, McEntee ML, Samuel L, et al. Adequate health literacy is associated with higher heart failure knowledge and self-care confidence in hospitalized patients. J Cardiovasc Nurs. 2011; 26(5): 359–367, doi: 10.1097/JCN.0b013e3181f16f88, indexed in Pubmed: 21099698.
26. Clark AM, Spaling M, Harkness K, et al. Determinants of effective heart failure self-care: a systematic review of patients' and caregivers' perceptions. Heart. 2014; 100(9): 716–721, doi: 10.1136/heartjnl-2013-304852, indexed in Pubmed: 24548920.
27. Bekelman DB, Havranek EP, Becker DM, et al. Symptoms, depression, and quality of life in patients with heart failure. J Card Fail. 2007; 13(8): 643–648, doi: 10.1016/j.cardfail.2007.05.005, indexed in Pubmed: 17923356.
28. Riegel B, Lee CS, Albert N, et al. From novice to expert: confidence and activity status determine heart failure self-care performance. Nurs Res. 2011; 60(2): 132–138, doi: 10.1097/NNR.0b013e31820978ec, indexed in Pubmed: 21317825.
29. Cajita MI, Cajita TR, Han HR. Health literacy and heart failure: a systematic review. J Cardiovasc Nurs. 2016; 31(2): 121–130, doi: 10.1097/JCN.0000000000000229, indexed in Pubmed: 25569150.
30. Murray MD, Tu W, Wu J, et al. Factors associated with exacerbation of heart failure include treatment adherence and health literacy skills. Clin Pharmacol Ther. 2009; 85(6): 651–658, doi: 10.1038/clpt.2009.7, indexed in Pubmed: 19262464.
31. Streiner DL, Norman GR. Cairney J. Health measurement scales: a practical guide to their development and use. Oxford University Press. https://oxfordmedicine.com/view/10.1093/med/9780199685219.001.0001/med-9780199685219.
32. McDonagh TA, Blue L, Clark AL, et al. European Society of Cardiology Heart Failure Association Committee on Patient Care. European Society of Cardiology Heart Failure Association Standards for delivering heart failure care. Eur J Heart Fail. 2011; 13(3): 235–241, doi: 10.1093/eurjhf/hfq221, indexed in Pubmed: 21159794.
33. Lainscak M, Blue L, Clark AL, et al. Self-care management of heart failure: practical recommendations from the Patient Care Committee of the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail. 2011; 13(2): 115–126, doi: 10.1093/eurjhf/hfq219, indexed in Pubmed: 21148593.
34. Vinluan CM, Wittman D, Morisky D. Effect of pharmacist discharge counselling on medication adherence in elderly heart failure patients: a pilot study. J Pharm Heal Serv Res. 2015; 6(2): 103–110, doi: 10.1111/jphs.12093.
35. Anderegg SV, Wilkinson ST, Couldry RJ, et al. Effects of a hospital-wide pharmacy practice model change on readmission and return to emergency department rates. Am J Health Syst Pharm. 2014; 71(17): 1469–1479, doi: 10.2146/ajhp130686, indexed in Pubmed: 25147171.
36. Szkiladz A, Carey K, Ackerbauer K, et al. Impact of pharmacy student and resident-led discharge counseling on heart failure patients. J Pharm Pract. 2013; 26(6): 574–579, doi: 10.1177/0897190013491768, indexed in Pubmed: 23797199.
37. Lowrie R, Johansson L, Forsyth P, et al. Experiences of a community pharmacy service to support adherence and self-management in chronic heart failure. Int J Clin Pharm. 2014; 36(1): 154–162, doi: 10.1007/s11096-013-9889-2, indexed in Pubmed: 24293306.
38. Parajuli DR, Franzon J, McKinnon RA, et al. Role of the Pharmacist for Improving Self-care and Outcomes in Heart Failure. Curr Heart Fail Rep. 2017; 14(2): 78–86, doi: 10.1007/s11897-017-0323-2, indexed in Pubmed: 28233258.
39. Ruppar TM, Cooper PS, Mehr DR, et al. Medication Adherence Interventions Improve Heart Failure Mortality and Readmission Rates: Systematic Review and Meta-Analysis of Controlled Trials. J Am Heart Assoc. 2016; 5(6), doi: 10.1161/JAHA.115.002606, indexed in Pubmed: 27317347.
40. Kang JE, Han NY, Oh JM, et al. Pharmacist-involved care for patients with heart failure and acute coronary syndrome: a systematic review with qualitative and quantitative meta-analysis. J Clin Pharm Ther. 2016; 41(2): 145–157, doi: 10.1111/jcpt.12367, indexed in Pubmed: 26954666.

Folia Cardiologica 2022
tom 17, nr 1, strony 27–34

ISSN 2353–7752
e-ISSN 2353–7760

Rola farmaceuty klinicznego w samoopiece pacjenta z niewydolnością serca

Agnieszka Skotnicka[1], Anna Jabłecka[2]

[1]Katedra i Zakład Technologii Postaci Leku *Collegium Chemicum* Uniwersytetu Medycznego im. Karola Marcinkowskiego w Poznaniu

[2]Zakład Farmakologii Klinicznej Katedry Kardiologii Uniwersytetu Medycznego im. Karola Marcinkowskiego w Poznaniu

Artykuł jest tłumaczeniem pracy: Skotnicka A, Jabłecka A. The role of a clinical pharmacist in self-care in heart failure. 2022; 17(1): 20–26. DOI: 10.5603/FC.2022.0004. Należy cytować wersję pierwotną

Streszczenie

Niewydolność serca (HF, *heart failure*) jest istotnym problemem zdrowotnym współczesnego społeczeństwa i jednym z najpowszechniej występujących zespołów przewlekłych, powiązanym z wysoką śmiertelnością oraz intensywnym wykorzystywaniem zasobów ochrony zdrowia, zarówno ludzkich, jak i finansowych. Strategie terapeutyczne powinny uwzględniać monitorowanie stanu zdrowia pacjentów od chwili wypisania, optymalizację farmakoterapii oraz modyfikację czynników środowiskowych. Samoopieka niesie ze sobą strategicznie istotny potencjał odciążający system opieki zdrowotnej w zakresie HF, pozwalający na celowany transfer nakładów i potencjalizację wydajności systemu opieki zdrowotnej. Udział farmaceuty klinicznego w procesie samoopieki w zakresie optymalizacji stosowanej farmakoterapii, ujednolicania farmakoterapii włączanej przez różnych specjalistów zaangażowanych w proces opieki pacjenta oraz współuczestnictwo w skoordynowanej opiece medycznej, uściślanie zaleceń w zakresie stosowania leków i fachowe doradztwo niosą realnie istotne konsekwencje przekładające się na efektywność prowadzonej terapii oraz wykorzystywanie zasobów ochrony zdrowia. Propagowanie samoopieki w HF wydaje się priorytetem strategicznym i włączenie samoopieki w rutynową opiekę medyczną pacjentów z HF powinno być równorzędne z zaopatrzeniem pacjenta w niezbędne do kontroli tego zespołu leki. Synergistyczne działania w efekcie przyczynią się do obniżenia stopnia ponownych hospitalizacji oraz poprawy jakości życia pacjentów z HF.

Słowa kluczowe: samoopieka, niewydolność serca, interwencje farmaceuty

Folia Cardiologica 2022; 17, 1: 27–34

Wstęp

Niewydolność serca (HF, *heart failure*) jest istotnym problemem zdrowotnym współczesnego społeczeństwa i jednym z najpowszechniej występujących zespołów przewlekłych, powiązanym z wysoką śmiertelnością oraz intensywnym wykorzystywaniem zasobów ochrony zdrowia, zarówno ludzkich, jak i finansowych. Zespół ten dotyka 1–2% populacji krajów rozwiniętych, przy czym w grupie wiekowej powyżej 75. roku życia występuje u co najmniej 10% populacji, zaś z prognoz wynika, że w najbliższych latach HF rozwinie się nawet u 20% społeczeństwa [1]. Szacuje się, że w Stanach Zjednoczonych w latach 2010–2030 częstość występowania wszystkich chorób układu sercowo-naczyniowego zwiększy się o 9,9%, a częstość występowania HF wzrośnie o 25%, zaś w związku ze stosowaniem coraz bardziej udoskonalonych i kompleksowych terapii koszty leczenia tej grupy chorych do roku 2030 zwiększą się aż o 215% [2]. Mimo że śmiertelność z powodu HF nieznacznie się obniża, to nadal pozostaje wysoka nawet u 40% w pierwszym

Adres do korespondencji: mgr farm. Agnieszka Skotnicka, Katedra i Zakład Technologii Postaci Leku, *Collegium Chemicum*, Uniwersytet Medyczny im. Karola Marcinkowskiego w Poznaniu, ul. Grunwaldzka 6, 60–780 Poznań, tel. +48 61 854 66 84, e-mail: askotnic@ump.edu.pl

roku od pierwszej hospitalizacji, a u chorych regularnie i wielokrotnie hospitalizowanych, szczególnie w pierwszym roku od pierwszej hospitalizacji, dotyczy nawet około 50% pacjentów [3].

Niewydolność serca jest zespołem klinicznym charakteryzującym się typowymi objawami podmiotowymi i przedmiotowymi, pojawiającymi się na skutek zmian fizjologicznych, takich jak na przykład zaburzenia gospodarki wodnoelektrolitowej, funkcja skurczowa naczyń krwionośnych, nadaktywność mięśnia sercowego. Kluczowym narzędziem skutecznej kontroli HF jest odpowiednio dobrana farmakoterapia, choć w wytycznych Europejskiego Towarzystwa Kardiologicznego (ESC, *European Society of Cardiology*) oraz Amerykańskiego Towarzystwa Kardiologicznego (AHA, *American Heart Association*) silnie wskazuje się na konieczność uzupełniania farmakoterapii o niefarmakologiczne strategie terapeutyczne realizowane przy współudziale wielodyscyplinarnych zespołów specjalistycznych oraz samych pacjentów. Strategie terapeutyczne powinny uwzględniać monitorowanie stanu zdrowia pacjentów od chwili wypisania ze szpitala, edukację oraz optymalizację farmakoterapii zależnie od objawów pogłębiania się HF [4].

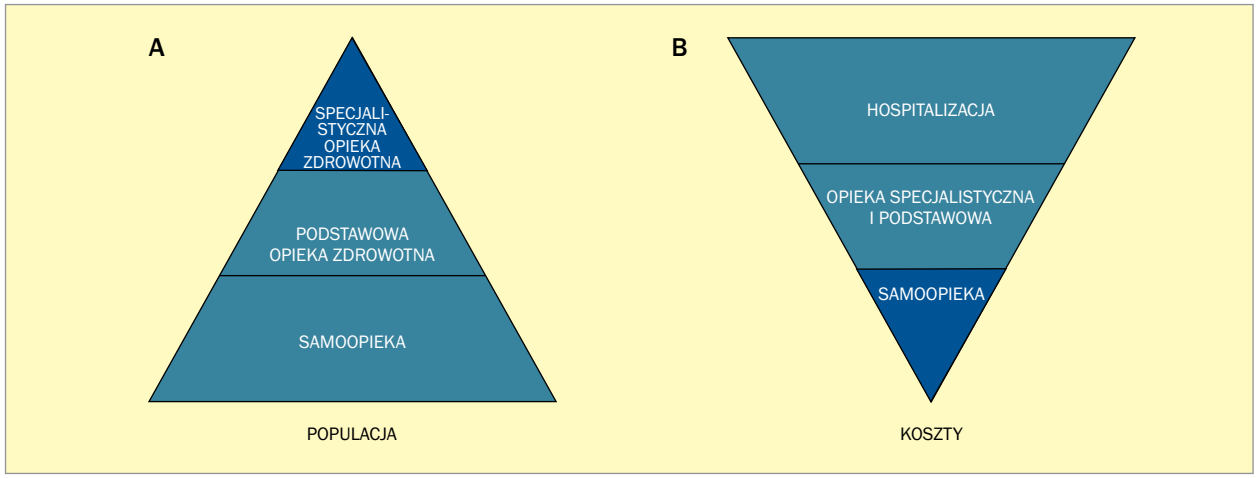
Samoopieka

Upowszechniony, tradycyjny model opieki zdrowotnej nie gwarantuje stałego nadzoru każdego pacjenta przez lekarza czy pielęgniarkę. Nieustanna opieka i kontrola nie tylko jest niewykonalna w państwowej ochronie zdrowia, ale i zbędna w przypadku interwencji jednorazowych, takich jak wszczepienie rozrusznika serca, w przypadku którego długoterminowo nie kontynuuje się współpracy z pacjentem, a sam pacjent nie ma wpływu na efektywność pracy urządzenia [5]. W przypadku większości pacjentów z HF inicjacja systematycznej i długoterminowej współpracy jest niezbędna, a im bardziej pozostaje świadoma, tym korzystniejszy rezultat terapii. Bezdyskusyjnie brak przestrzegania zaleceń terapeutycznych w zakresie stosowania leków (ang. *medication adherence*) przyczynia się do progresji choroby. Dlatego wszelkie zalecenia dotyczące modyfikowalnych czynników ryzyka, takich jak dieta, aktywność fizyczna czy farmakoterapii, powinny być przekazywane na drodze efektywnej, dostosowanej do pacjenta komunikacji, z uwzględnieniem faktu, że wdrażanie koniecznych zaleceń często wiąże się z dyskomfortem i wymaga wyrzeczeń oraz wysiłku pacjenta. Warunkiem współpracy jest odpowiednio dobrany komunikat, zawierający szacunkowe korzyści i ryzyko. Świadomi pacjenci, ufający w treść i sens zaleceń odnośnie do postępowania terapeutycznego, mogą korzystnie wpływać na własne samopoczucie i wyniki leczenia [6].

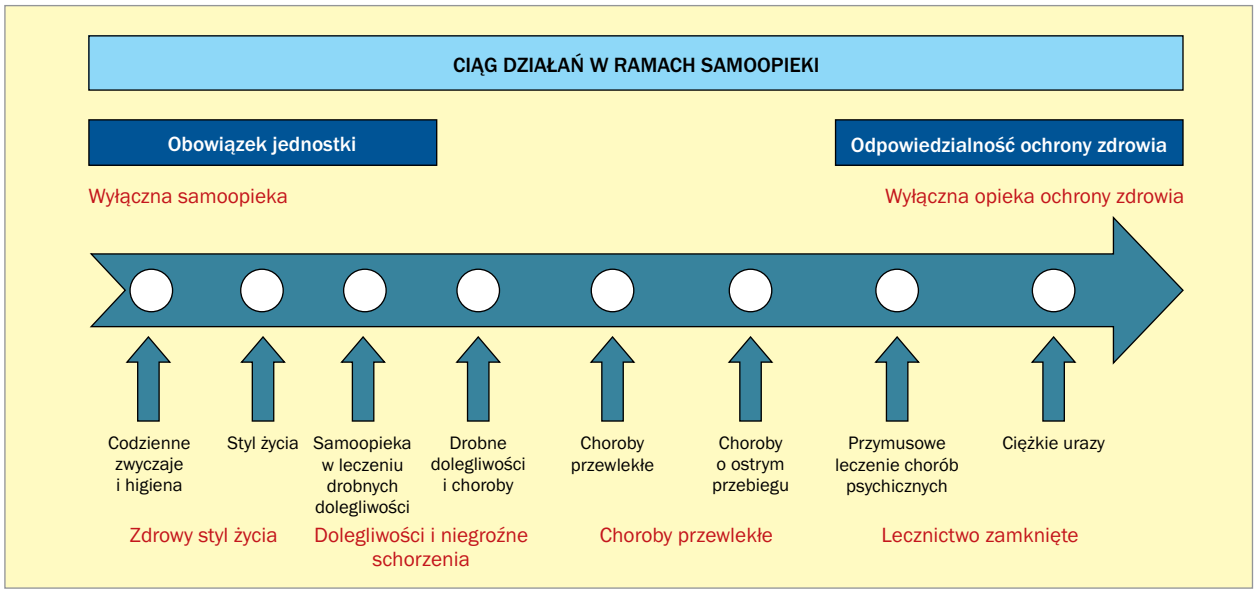
Dlatego też stosownie zarówno względem wytycznych klinicznych, jak i postępu technologicznego światowe systemy opieki zdrowotnej muszą ewoluować w celu utrzymania swej wydolności ekonomicznej i infrastrukturalnej [7]. Interwencje służące utrzymaniu wydolności systemów opieki zdrowotnej koncentrują się na racjonalnym uzyskiwaniu oszczędności, między innymi przez zmniejszanie liczby epizodów hospitalizacji, stanowiących przeważającą część nakładów na opiekę pacjentów z HF, wynoszącą nawet około 70% całkowitych wydatków przeznaczanych na leczenie tego schorzenia [8]. Wiadomo, że całkowity odsetek hospitalizacji i odsetek epizodów możliwych do uniknięcia jest wysoki [9, 10]. Ponieważ koszty związane z nawracającą i długotrwałą hospitalizacją w wyniku nasilenia czy zaostrzenia przebiegu choroby [10] są najczęściej skutkiem niedostatecznej świadomości i samoopieki pacjentów [11], to współczesny kierunek rozwoju systemu opieki zdrowotnej polega zwiększaniu zaangażowania pacjenta w proces leczenia, czyli na odejściu od tradycyjnego modelu opieki zdrowotnej, przy biernym udziale chorego w prowadzonym procesie leczenia (ryc. 1) [12, 13]. Potwierdzono, że koszty opieki zdrowotnej pacjentów świadomych, współzaangażowanych, podejmujących samodzielne decyzje dotyczące kontroli własnego stanu zdrowia, są o 8–20% niższe od kosztów opieki nad pacjentami biernymi [14].

Najczęstsze przyczyny hospitalizacji pacjentów z HF wynikają z opóźnionej reakcji pacjenta lub jej całkowitego braku na pogarszającą się kontrolę przewlekłej HF, niskiego poziomu *adherence* i braku umiejętności samoopieki [15, 16]. Zaostrzenie przebiegu HF i hospitalizacje możliwe do uniknięcia są wyraźnie powiązane z niepowodzeniem procesu samoopieki [11] i dlatego zwiększanie efektywności tego trzonu opieki zdrowotnej ma fundamentalną rolę w stabilizacji stanu zdrowia, optymalizacji efektów terapii i poprawy jakości życia pacjentów [17]. Rokowanie HF zależy od dwóch czynników; pierwszy to zależny od lekarza prowadzącego dobór farmakoterapii, a drugi, zależny od pacjenta, jest oparty na samoopiece, włączając motywację do przestrzegania zaleceń diagnostycznych i terapeutycznych [4].

Samoopieka to zespół samodzielnych działań świadomego swej choroby pacjenta, samodzielnie inicjowanych w celu osiągnięcia i utrzymania odpowiedniego stanu zdrowia. Są to głównie działania prewencyjne dotyczące zdrowego stylu życia czy też udział w terapii [13]. Opóźnia to rozwój powikłań choroby oraz umożliwia kontrolę i radzenie sobie z pojawiającymi się objawami. W ogólnym założeniu samoopieka obejmuje modyfikację i kontrolę takich czynników, jak czynniki środowiskowe, socjoekonomiczne czy samodzielne stosowanie leków. Ten ostatni element ma szczególne znaczenie, zarówno jeśli chodzi o samodzielny wybór, jaki i sposób ich stosowania w odpowiedzialnym i świadomym procesie leczenia. Samoopieka stanowi kontinuum interwencji i świadczeń (ryc. 2), na które składają się z jednej strony szereg działań podejmowanych bezpośrednio i wyłącznie przez pacjenta, z jego pełną odpowiedzialnością, jak na przykład podejmowanie decyzji w zakresie codziennych aktywności, leczenie powszechnie występujących, w tym sezonowych, dolegliwości, zaś z drugiej strony kompleksowa



Rycina 1A, B. Piramida samoopieki (na podstawie [13])



Rycina 2. Ciąg działań samoopieki (na podstawie [18])

terapia ostrych i przewlekłych chorób, prowadzona w pełni w ramach specjalistycznej ochrony zdrowia [18].

Samoopieka w HF służy wypracowaniu i zastosowaniu umiejętności dotyczących wspomagania niefarmakologicznego i regularnego monitorowania przez pacjenta swojego stanu zdrowia [4]. Jako najważniejsze elementy kontroli wskazuje się objawy i rozpoznawanie istotnych zmian w ich nasileniu, a także umiejętność podjęcia na podstawie samoobserwacji decyzji o konieczności skontaktowania się ze specjalistą.

Najważniejsze działania w zakresie samoopieki poprawiające rokowanie HF to pogłębianie wiedzy na temat choroby, przestrzeganie zaleceń terapeutycznych i dietetycznych, czynne zaangażowanie w monitorowanie objawów i umiejętności interpretacji symptomów świadczących o pogarszaniu się kontroli HF, umiejętności podejmowania działań na wczesnym etapie pogarszania się stanu zdrowia, regularna aktywność fizyczna, kontrola nad używkami, terapia chorób towarzyszących [16]. Wdrażanie zaleceń dietetycznych oraz monitorowanie parametrów, takich jak ciśnienie tętnicze czy masa ciała, znaczącą poprawiają rokowanie [19, 20], zaś wytrwałość w samoopiece redukuje liczbę hospitalizacji, ponownych hospitalizacji [21], śmiertelność [22] oraz poprawia jakość życia pacjentów [23].

Bodźcami i warunkami popularyzacji i rozpowszechniania się samoopieki są wzrost dostępności informacji

medycznej dzięki rozwojowi źródeł internetowych, zwiększenie dostępności leków, zmiany w stylu życia czy rosnący potencjał społeczny do udziału w procesie leczenia. Poziom wykształcenia społeczeństwa stale wzrasta, podobnie jak poziom świadomej samoobserwacji w kontekście kondycji zdrowotnej, co łącznie skutkuje większym udziałem pacjenta w procesie leczenia. Zakres świadomości zdrowotnej i umiejętności oraz chęci pozyskiwania informacji o chorobie i jej objawach, ale również ograniczona dostępność do lekarzy i przychodni, są dodatkowymi bodźcami do rozpowszechniania się samoopieki. Ponadto umożliwia ona pacjentom przejmowanie w pewnym stopniu odpowiedzialności za własne zdrowie, a rządom, w kontekście narastającego przeciążania systemów opieki zdrowotnej, zarówno pod względem kosztów, jak i wydolności infrastrukturalnej starzejących się społeczeństw, modyfikacje mechanizmu uwalniania zasobów.

Podstawą wdrażania i realizacji samoopieki jest dostateczny poziom alfabetyzmu zdrowotnego (ang. *health literacy*), gwarantujący tym samym, że uzyskiwane informacje i zalecenia terapeutyczne umożliwią podejmowanie świadomych decyzji i działań [11]. Kluczowym elementem, niezbędnym do zastosowania się przez pacjenta do zaleceń terapeutycznych, jest ich zrozumienie. Pacjenci z HF na całym świecie mają lub mogą mieć trudności z przyswajaniem zaleceń odnośnie do stosowanych leków, szczególnie złożonych schematów, oraz wdrażaniem modyfikacji stylu życia. Aby skutecznie dostosować przekazywanie zaleceń, należy określić: funkcjonalny alfabetyzm zdrowotny, na który składają się umiejętność czytania, pisania i liczenia na poziomie adekwatnym do potrzeb codziennych sytuacji życiowych, motywację i umiejętności pacjentów do uzyskiwania dostępu, rozumienia, oceny i stosowania informacji zdrowotnych w celu podejmowania codziennych decyzji [24]. Określenie poziomu alfabetyzmu pacjenta umożliwia tworzenie i w konsekwencji dobór adekwatnych materiałów informacyjnych, na przykład ulotek dołączonych do preparatów farmaceutycznych, plakatów czy kampanii edukacyjnych. Niestety, znaczny odsetek pacjentów nie rozumie i w konsekwencji nie przestrzega podstawowych zaleceń w zakresie samoopieki na podstawie przeczytanych informacji, tylko co drugi pacjent prawidłowo odczytuje zalecenia, co trzeci natomiast nie rozumie zalecenia o przyjęciu leku na czczo [24]. Ponieważ udowodniono, że poziom alfabetyzmu zdrowotnego skutkuje wzrostem stopnia przestrzegania zaleceń, to celem strategicznym służby zdrowia i specjalistów, takich jak lekarze, farmaceuci, pielęgniarki czy dietetycy oraz organizacji zajmujących się edukacją i wdrażaniem programów profilaktycznych, jest poprawa alfabetyzmu zdrowotnego.

Pacjenci z niskim poziomem alfabetyzmu zdrowotnego z trudnością przetwarzają i w konsekwencji przyswajają informacje dotyczące ich stanu zdrowia, interpretacji objawów oraz pojmowania ustnych komunikatów od kardiologa czy lekarza. Są też 1,5 do 3 razy bardziej narażeni na wystąpienie zdarzeń niepożądanych i działań ubocznych [18]. Analiza dotychczas publikowanych wyników badań wskazuje, że alfabetyzm zdrowotny u 42%hospitalizowanych pacjentów z HF jest na poziomie niewystarczającym, zaś u 19% — marginalny [25].

Brak elementarnej wiedzy na temat HF oraz samoopieki jest szeroko rozpowszechnionym zjawiskiem zarówno wśród pacjentów, jak i ich opiekunów. W wielu badaniach dowiedziono, że niska zdolność pacjentów do zaangażowania się w proces samoopieki w HF jest powiązana z ogólnym, niskim poziomem wykształcenia i małą wiedzą z zakresu samoopieki. Jako obszary, w których kompetencje pacjentów okazują się niewystarczające, wskazuje się ograniczenie spożycia soli, przestrzeganie zaleceń odnośnie do stosowania leków, kontrolę masy ciała oraz aktywność fizyczną. Brak wiedzy przyczynia się do dezorientacji, opóźnień w poszukiwaniu pomocy, niepewności odnośnie do przyszłości, a także nieumiejętności samodzielnej opieki. Aby zwiększyć korzyści z działań pacjenta z HF, konieczne jest regularne badanie poziomu umiejętności rozwiązywania problemów oraz praktykowania działań [26].

Podstawowe bariery w rozumieniu zaleceń terapeutycznych to zawiły system opieki zdrowotnej, brak poczucia dostatecznej kompetencji przy podejmowaniu samodzielnych decyzji odnośnie do leczenia, fachowe słownictwo materiałów informacyjnych oraz brak umiejętności komunikacji przedstawicieli służby zdrowia. Pacjenci wskazują na brak doświadczenia w samoobserwacji i w podejmowaniu decyzji [16]. Oczywistymi ograniczeniami dla zwiększania udziału pacjenta w terapii są upośledzone funkcje poznawcze, współistniejąca depresja, ograniczająca możliwości samomotywowania, lęk przed samodzielnym podjęciem działań czy brak wsparcia społecznego [14]. Choroby towarzyszące, szczególnie u pacjentów powyżej 73. roku życia, utrudniają prawidłową interpretację i rozróżnianie pojawiającej się duszności czy zmęczenia. Ponadto HF rzadko występuje jako jedyny zespół kliniczny; zazwyczaj towarzyszą jej inne schorzenia, wpływając na liczbę objawów wymagających interpretacji. Pacjenci z HF doświadczają średnio dziewięciu objawów [27], mało specyficznych i trudnych do rozróżnienia. Barierą realizacji samoopieki jest również brak uznania wpływu samoopieki i współpracy klinicystów, ich wyłączne skupienie na celach farmakologicznych [14]. Klinicyści wątpią w kompetencje pacjentów, co w efekcie znacznie zmniejsza odsetek chorych biorących aktywny udział w procesie leczenia [28].

Edukacja w HF

Poziom wiedzy pacjentów z HF na temat własnego stanu zdrowia jest niski, co skutkuje wysokim odsetkiem hospitalizacji [29]. Wzrost alfabetyzmu zdrowotnego do poziomu zadowalającego niesie realne korzyści w postaci istotnego

Tabela 1. Bariery realizacji samoopieki w niewydolności serca (HF, *heart failure*) i proponowane strategie i interwencje

Bariera	Strategia	Interwencja
Zdolności funkcjonalne i upośledzenie wzroku, słuchu	Ocena stopnia upośledzenia Dostosowanie materiałów informacyjnych oraz stosowanych metod komunikacji	Zastosowanie pomocy dydaktycznych w postaci ergonomicznych urządzeń mobilnych z dużymi przyciskami, dużą czcionką, ilustracjami — dostosowanych do pacjentów w podeszłym wieku
Ograniczenie funkcji poznawczych, demencja	Wykorzystywanie narzędzi i metod dostosowanych do pacjenta, komunikacja oparta na wielokrotnym powtarzaniu informacji w celu jej utrwalenia, dzielenie komunikatu na przyswajalne porcje, włączenie bezpośredniego opiekuna pacjenta w proces edukacji	Interaktywne narzędzia edukacyjne Zwięzłe materiały informacyjne, np. ulotki Wielokrotne powtarzanie
Błędne przekonania i brak podstawowej wiedzy na temat choroby	Analiza przyczyny błędnych przekonań i ocena poziomu wiedzy pacjenta na temat choroby	Podstawowa edukacja w zakresie choroby i terapii
Niski poziom motywacji i zainteresowania procesem leczenia	Dostosowywanie do potrzeb Wnikliwa i konstruktywna edukacja	Ocena potrzeb pacjenta i oczekiwań w zakresie poziomu wiedzy Opieka holistyczna Weryfikacja depresji i osłabienia
Niska samoocena i brak wiary we własne możliwości	Materiały i metody niezawierające elementu groźby i kary Pozytywne motywowanie Wsparcie	Wypracowanie pozytywnej współpracy i interakcji z pacjentem Edukacja z elementami wsparcia społecznego, np. teleporady, wizyty w domu

zmniejszenia odsetka hospitalizacji [30]. Edukacja w zakresie wiedzy o HF, jej przebiegu i wpływu niestosowania się do zaleceń powinna być wprowadzana w postaci podstawowej jak najszybciej jest to możliwe, dopasowana indywidualnie, zależnie od fazy akceptacji choroby, zaś struktura i porządek przekazywania treści powinny być spójne z planem opieki. Wyzwaniem dla poprawy kompetencji zdrowotnych jest dostosowanie materiałów edukacyjnych do określonych grup społecznych, uwzględniając kulturę, płeć, wiek oraz inne indywidualne cechy (tab. 1) [31].

Edukacja z zakresu samoopieki skierowana do osób z niskim poziomem alfabetyzmu zdrowotnego może poprawiać efektywność samoopieki, zwiększać świadomość pacjentów zagrożonych niską efektywnością terapii HF. Rozpowszechnianie samoopieki w HF wymaga przede wszystkim zwiększania zaangażowania przedstawicieli ochrony zdrowia, uświadamianie lekarzy w zakresie potencjału samoopieki i sposobów jej propagowania. Doskonałą strategią jest włączenie w proces opieki przedstawicieli innych zawodów medycznych i tworzenie zespołów interdyscyplinarnych, odpowiedzialnych za samoopiekę [32] i edukację [33].

Bezpośredni kontakt z pacjentem poza stresogennym środowiskiem klinicznym oraz współczesna rewolucja w zakresie tradycyjnych obowiązków, oraz rewolucja produkcji leków stawia farmaceutę na idealnej pozycji do edukacji medycznej i modyfikacji alfabetyzmu zdrowotnego [17]. Farmaceuta jest jednym z najlepiej przygotowanych przedstawicieli medycznego personelu fachowego do pomocy pacjentom w zrozumieniu procesu leczenia. W klasycznym modelu opieki zdrowotnej rola farmaceuty koncentruje się głównie na zaopatrywaniu pacjenta w leki gotowe i recepturowe. Jednak w ostatnich dekadach rola ta ewoluuje w kierunku wzrostu zaangażowania w proces samoopieki.

Rola farmaceuty w procesie samoleczenia to praca w czterech obszarach: jako komunikatora, jako dostawcy leków, jako nadzorcy i propagatora. To farmaceuta inicjuje dialog z pacjentem, weryfikuje objawy i decyduje o konieczności skierowania pacjenta do lekarza. Wspiera pacjenta w wyborze leków, gwarantując prawidłowe ich użycie na podstawie przyjętych zasad współpracy z innymi przedstawicielami ochrony zdrowia. Farmaceuta kliniczny prowadzi poradnictwo przy wypisaniu ze szpitala, analizę wdrożonej farmakoterapii i edukuje w zakresie nowych zaleceń, zaś na poziomie apteki ogólnodostępnej prowadzi opiekę farmaceutyczną, poradnictwo na temat drobnych dolegliwości.

Udział farmaceuty na wspominanych etapach procesu leczenia pacjenta z HF skutkuje poprawą stopnia *adherence*, ale korzyści te zanikają po 3 miesiącach od wypisania [34], co wskazuje na konieczność systematycznego

Tabela 2. Przegląd tematyki edukacji w niewydolności serca

Poradnictwo ogólne	Opisanie objawów i dolegliwości
	Etiologia
	Zasady monitorowania stanu zdrowia
	Samodzielna kontrola objawów
	Kontrola masy ciała
	Przesłanki do farmakoterapii
	Zalecenia w zakresie stosowania leków
	Prognostyka
Doradztwo fachowe w zakresie farmakoterapii	Efekty stosowania leków, objawy niepożądane, objawy zatrucia
	Sposób przyjmowania leków
	Interakcje lekowe (potencjalne i możliwe do uniknięcia)
	Odpowiednie stosowanie diuretyków
Aktywność fizyczna	Odpoczynek
	Systematyczna umiarkowana aktywność fizyczna
	Uwzględnienie charakteru pracy
	Aktywność płciowa
Dieta i używki	Ograniczenie spożywania soli
	Ograniczenie i kontrola spożycia płynów
	Unikanie spożycia alkoholu
	Rzucenie palenia
	Dieta redukująca masę ciała
Szczepienia	Grypa
	Pneumokoki
	SARS-CoV-2
Podróże	Zalecenia dotyczące podróży samolotem
	Ryzyko związane z klimatem zwrotnikowym, dużą wilgotnością i wysoką temperaturą oraz na wysokości ponad poziomem morza o zmniejszonej zawartości tlenu w powietrzu

SARS-CoV-2 (*severe acute respiratory syndrome coronavirus 2*) — koronawirus zespołu ostrej niewydolności oddechowej 2

prowadzenia tych działań. Edukacja prowadzona przez farmaceutę (tab. 2) skutkuje zmniejszeniem śmiertelności ogólnej i z powodu HF [35] oraz obniża odsetek ponownych hospitalizacji [34]. Interwencje farmaceuty mają pośredni wymiar ekonomiczny, gdyż eliminacja błędów lekowych pozwala uniknąć kosztów z nimi związanych [36]. Pacjenci z HF objęci opieką farmaceutyczną stają się bardziej otwarci w werbalizowaniu swoich obaw czy wątpliwości, co pozwala trafniej dobrać zakres edukacji i eliminować bariery samoopieki [37].

Włączenie farmaceuty w realizację samoopieki niesie ze sobą korzyści kliniczne, poprawę jakości życia pacjentów, w zakresie zarządzania opieką medyczną [38], wzrost *adherence* w HF [39], obniża odsetek ponownych hospitalizacji w pierwszych 30 dniach od wypisania [35]. Zaangażowanie farmaceuty w proces samoopieki [40] w zakresie optymalizacji stosowanej farmakoterapii, ujednolicania farmakoterapii wdrażanej przez różnych specjalistów i świadczeniodawców, uściślanie zaleceń odnośnie do stosowania leków, udział w odpowiednim stosowaniu diuretyków zależnie od nasilenia objawów niesie realnie istotne konsekwencje przekładające się na efektywność prowadzonej terapii oraz wykorzystywanie zasobów ochrony zdrowia.

Podsumowanie

Samoopieka niesie ze sobą strategicznie istotny potencjał odciążający system opieki zdrowotnej w zakresie HF, pozwalając na celowany transfer nakładów w kierunku zwiększania udziału nowoczesnych i efektywnych terapii, a tym samym potencjalizację wydajności systemu opieki zdrowotnej. Propagowanie samoopieki w HF wydaje się priorytetem strategicznym i włączanie samoopieki w rutynową opiekę medyczną pacjentów z HF powinno być równorzędne z zaopatrzeniem pacjenta w niezbędne do kontroli tego zespołu leki. Synergistyczne działanie w efekcie przyczynią się do obniżenia stopnia ponownych hospitalizacji oraz poprawy jakości życia pacjentów z HF.

Konflikt interesów

Brak.

Finansowanie

Brak.

Piśmiennictwo

1. Lloyd-Jones DM, Larson MG, Leip EP, et al. Framingham Heart Study. Lifetime risk for developing congestive heart failure: the Framingham Heart Study. Circulation. 2002; 106(24): 3068–3072, doi: 10.1161/01.cir.0000039105.49749.6f, indexed in Pubmed: 12473553.
2. Chen J, Normand SLT, Wang Y, et al. National and regional trends in heart failure hospitalization and mortality rates for Medicare beneficiaries, 1998-2008. JAMA. 2011; 306(15): 1669–1678, doi: 10.1001/jama.2011.1474, indexed in Pubmed: 22009099.
3. Howlett JG, Johnstone DE, Sketris I, et al. Improving Cardiovascular Outcomes in Nova Scotia investigators. Identifying opportunities to address the congestive heart failure burden: the Improving Cardiovascular Outcomes in Nova Scotia (ICONS) study. Can J Cardiol. 2003; 19(4): 439–444, indexed in Pubmed: 12704493.
4. Ponikowski P, Voors AA, Anker SD, et al. ESC Scientific Document Group. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016; 37(27):

2129–2200, doi: 10.1093/eurheartj/ehw128, indexed in Pubmed: 27206819.
5. Cleland JGF, Daubert JC, Erdmann E, et al. Longer-term effects of cardiac resynchronization therapy on mortality in heart failure [the CArdiac REsynchronization-Heart Failure (CARE-HF) trial extension phase]. Eur Heart J. 2006; 27(16): 1928–1932, doi: 10.1093/eurheartj/ehl099, indexed in Pubmed: 16782715.
6. Cleland JGF, Ekman I. Enlisting the help of the largest health care workforce--patients. JAMA. 2010; 304(12): 1383–1384, doi: 10.1001/jama.2010.1387, indexed in Pubmed: 20858885.
7. What do we mean by self care and why is it good for people? The self-care continuum. Self Care Forum. https://www.selfcareforum.org/about-us/what-do-we-mean-by-self-care-and-why-is-good-for-people/ (February 15, 2021).
8. Cleland JG, Swedberg K, Poole-Wilson PA. Successes and failures of current treatment of heart failure. Lancet. 1998; 352(Suppl 1): SI19–SI28, doi: 10.1016/s0140-6736(98)90015-0, indexed in Pubmed: 9736476.
9. Linné AB, Liedholm H, Jendteg S, et al. Health care costs of heart failure: results from a randomised study of patient education. Eur J Heart Fail. 2000; 2(3): 291–297, doi: 10.1016/s1388-9842(00)00089-1, indexed in Pubmed: 10938491.
10. Liao L, Anstrom KJ, Gottdiener JS, et al. Long-term costs and resource use in elderly participants with congestive heart failure in the Cardiovascular Health Study. Am Heart J. 2007; 153(2): 245–252, doi: 10.1016/j.ahj.2006.11.010, indexed in Pubmed: 17239685.
11. Formiga F, Chivite D, Manito N, et al. Hospitalization due to acute heart failure. Role of the precipitating factors. Int J Cardiol. 2007; 120(2): 237–241, doi: 10.1016/j.ijcard.2006.10.004, indexed in Pubmed: 17175043.
12. Self-care: a winning solution. Association of the European Self-Medication Industry. http://www.aesgp.eu/media/cms_page_media/68/Self-Care%20A%20Winning%20Solution.pdf (Accessed February 2021).
13. Bell J, Dziekan G, Pollack C, et al. Self-care in the twenty first century: a vital role for the pharmacist. Adv Ther. 2016; 33(10): 1691–1703, doi: 10.1007/s12325-016-0395-5, indexed in Pubmed: 27535290.
14. Health policy brief: patient engagement. Health affairs. http://www.healthaffairs.org/ healthpolicybriefs/ (February 15, 2021).
15. Riegel B, Moser DK, Anker SD, et al. American Heart Association Council on Cardiovascular Nursing, American Heart Association Council on Cardiovascular Nursing, American Heart Association Council on Clinical Cardiology, American Heart Association Council on Nutrition, Physical Activity, and Metabolism, American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research. State of the science: promoting self-care in persons with heart failure: a scientific statement from the American Heart Association. Circulation. 2009; 120(12): 1141–1163, doi: 10.1161/CIRCULATIONAHA.109.192628, indexed in Pubmed: 19720935.
16. Evangelista LS, Rasmusson KD, Laramee AS, et al. Health literacy and the patient with heart failure — implications for patient care and research: a consensus statement of the Heart Failure Society of America. J Card Fail. 2010; 16(1): 9–16, doi: 10.1016/j.cardfail.2009.10.026, indexed in Pubmed: 20123313.
17. Moser DK, Dickson V, Jaarsma T, et al. Role of self-care in the patient with heart failure. Curr Cardiol Rep. 2012; 14(3): 265–275, doi: 10.1007/s11886-012-0267-9, indexed in Pubmed: 22437374.
18. Dewalt DA, Berkman ND, Sheridan S, et al. Literacy and health outcomes: a systematic review of the literature. J Gen Intern Med. 2004; 19(12): 1228–1239, doi: 10.1111/j.1525-1497.2004.40153.x, indexed in Pubmed: 15610334.
19. Hammash MH, Crawford T, Shawler C, et al. Beyond social support: self-care confidence is key for adherence in patients with heart failure. Eur J Cardiovasc Nurs. 2017; 16(7): 632–637, doi: 10.1177/1474515117705939, indexed in Pubmed: 28443677.
20. Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation. 2013; 128(16): 1810–1852, doi: 10.1161/CIR.0b013e31829e8807, indexed in Pubmed: 23741057.
21. Jovicic A, Holroyd-Leduc JM, Straus SE. Effects of self-management intervention on health outcomes of patients with heart failure: a systematic review of randomized controlled trials. BMC Cardiovasc Disord. 2006; 6: 43, doi: 10.1186/1471-2261-6-43, indexed in Pubmed: 17081306.
22. Albert NM. Promoting self-care in heart failure: state of clinical practice based on the perspectives of healthcare systems and providers. J Cardiovasc Nurs. 2008; 23(3): 277–284, doi: 10.1097/01.JCN.0000305095.27635.4f, indexed in Pubmed: 18437070.
23. Jonkman NH, Westland H, Groenwold RHH, et al. Do self-management interventions work in patients with heart failure? An individual patient data meta-analysis. Circulation. 2016; 133(12): 1189–1198, doi: 10.1161/CIRCULATIONAHA.115.018006, indexed in Pubmed: 26873943.
24. McDonald HP, Garg AX, Haynes RB. Interventions to enhance patient adherence to medication prescriptions: scientific review. JAMA. 2002; 288(22): 2868–2879, doi: 10.1001/jama.288.22.2868, indexed in Pubmed: 12472329.
25. Dennison CR, McEntee ML, Samuel L, et al. Adequate health literacy is associated with higher heart failure knowledge and self-care confidence in hospitalized patients. J Cardiovasc Nurs. 2011; 26(5): 359–367, doi: 10.1097/JCN.0b013e3181f16f88, indexed in Pubmed: 21099698.
26. Clark AM, Spaling M, Harkness K, et al. Determinants of effective heart failure self-care: a systematic review of patients' and caregivers' perceptions. Heart. 2014; 100(9): 716–721, doi: 10.1136/heartjnl-2013-304852, indexed in Pubmed: 24548920.
27. Bekelman DB, Havranek EP, Becker DM, et al. Symptoms, depression, and quality of life in patients with heart failure. J Card Fail. 2007; 13(8): 643–648, doi: 10.1016/j.cardfail.2007.05.005, indexed in Pubmed: 17923356.
28. Riegel B, Lee CS, Albert N, et al. From novice to expert: confidence and activity status determine heart failure self-care performance. Nurs Res. 2011; 60(2): 132–138, doi: 10.1097/NNR.0b013e31820978ec, indexed in Pubmed: 21317825.
29. Cajita MI, Cajita TR, Han HR. Health literacy and heart failure: a systematic review. J Cardiovasc Nurs. 2016; 31(2): 121–130, doi: 10.1097/JCN.0000000000000229, indexed in Pubmed: 25569150.
30. Murray MD, Tu W, Wu J, et al. Factors associated with exacerbation of heart failure include treatment adherence and health literacy skills. Clin Pharmacol Ther. 2009; 85(6): 651–658, doi: 10.1038/clpt.2009.7, indexed in Pubmed: 19262464.
31. Streiner DL, Norman GR. Cairney J. Health measurement scales: a practical guide to their development and use. Oxford University Press. https://oxfordmedicine.com/view/10.1093/med/9780199685219.001.0001/med-9780199685219.

32. McDonagh TA, Blue L, Clark AL, et al. European Society of Cardiology Heart Failure Association Committee on Patient Care. European Society of Cardiology Heart Failure Association Standards for delivering heart failure care. Eur J Heart Fail. 2011; 13(3): 235–241, doi: 10.1093/eurjhf/hfq221, indexed in Pubmed: 21159794.
33. Lainscak M, Blue L, Clark AL, et al. Self-care management of heart failure: practical recommendations from the Patient Care Committee of the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail. 2011; 13(2): 115–126, doi: 10.1093/eurjhf/hfq219, indexed in Pubmed: 21148593.
34. Vinluan CM, Wittman D, Morisky D. Effect of pharmacist discharge counselling on medication adherence in elderly heart failure patients: a pilot study. J Pharm Heal Serv Res. 2015; 6(2): 103–110, doi: 10.1111/jphs.12093.
35. Anderegg SV, Wilkinson ST, Couldry RJ, et al. Effects of a hospitalwide pharmacy practice model change on readmission and return to emergency department rates. Am J Health Syst Pharm. 2014; 71(17): 1469–1479, doi: 10.2146/ajhp130686, indexed in Pubmed: 25147171.
36. Szkiladz A, Carey K, Ackerbauer K, et al. Impact of pharmacy student and resident-led discharge counseling on heart failure patients. J Pharm Pract. 2013; 26(6): 574–579, doi: 10.1177/0897190013491768, indexed in Pubmed: 23797199.
37. Lowrie R, Johansson L, Forsyth P, et al. Experiences of a community pharmacy service to support adherence and self-management in chronic heart failure. Int J Clin Pharm. 2014; 36(1): 154–162, doi: 10.1007/s11096-013-9889-2, indexed in Pubmed: 24293306.
38. Parajuli DR, Franzon J, McKinnon RA, et al. Role of the Pharmacist for Improving Self-care and Outcomes in Heart Failure. Curr Heart Fail Rep. 2017; 14(2): 78–86, doi: 10.1007/s11897-017-0323-2, indexed in Pubmed: 28233258.
39. Ruppar TM, Cooper PS, Mehr DR, et al. Medication Adherence Interventions Improve Heart Failure Mortality and Readmission Rates: Systematic Review and Meta-Analysis of Controlled Trials. J Am Heart Assoc. 2016; 5(6), doi: 10.1161/JAHA.115.002606, indexed in Pubmed: 27317347.
40. Kang JE, Han NY, Oh JM, et al. Pharmacist-involved care for patients with heart failure and acute coronary syndrome: a systematic review with qualitative and quantitative meta-analysis. J Clin Pharm Ther. 2016; 41(2): 145–157, doi: 10.1111/jcpt.12367, indexed in Pubmed: 26954666.

REVIEW ARTICLE

Folia Cardiologica 2022
vol. 17, no. 1, pages 35–39
DOI: 10.5603/FC.2022.0005

ISSN 2353–7752
e-ISSN 2353–7760

Electrocardiographic changes in patients with COVID-19

Patryk Siedlecki, Małgorzata Kurpesa

Chair and First Department of Cardiology, Medical University of Lodz, Władysław Bieganski Voivodship Specialist Hospital, Lodz, Poland

Abstract

Electrocardiography is one of the basic diagnostic tests performed in hospitalized coronavirus disease 2019 (COVID-19) patients. Due to its wide availability and low cost, it is useful in the initial evaluation of COVID-19 patients with a history of cardiovascular disease, and patients with suspected cardiovascular complications in the course of the infection. Electrocardiographic findings seen in COVID-19 patients may include P wave and atrioventricular conduction abnormalities, QRS complex alterations including their fragmentation, evidence of right ventricular overload, ST-T changes, and QTc interval prolongation. The most common cardiac arrhythmias are supraventricular arrhythmias, particularly atrial fibrillation.

Key words: ECG, electrocardiogram, COVID-19, SARS-CoV-2, cardiac arrhythmia

Folia Cardiologica 2022; 17, 1: 35–39

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), a RNA virus of the betacoronavirus genus. Its reservoir are infected persons, and its transmission is airborne, mostly by droplets, but likely also by aerosol and direct contact. The receptor used for viral entry into the cells is angiotensin converting enzyme type 2 (ACE2). The incubation period is typically 2 to 14 days but it may be prolonged up to 27 days. Infection may be asymptomatic or it may manifest with unspecific symptoms, such as decreased or elevated body temperature, fatigue, cough, rhinitis, smell and taste impairment, and headache. In some cases, pneumonia develops, or even acute respiratory distress syndrome (ARDS) or sepsis. Immune system response to viral antigens plays a major role in the pathomechanism of severe disease forms, with the release of proinflammatory cytokines and chemokines, leading to a systemic inflammatory reaction known as cytokine storm [1].

Although more severe forms of COVID-19 mostly affect the respiratory system, cardiovascular complications may also be important. In addition, patients with a history of cardiovascular disease are at increased risk of severe disease course [1, 2]. Cardiovascular complications related to COVID-19 may be divided into five categories:

- Myocardial damage (related to myocardial ischemia or myocarditis);
- Cardiac arrhythmia;
- New-onset heart failure or exacerbation of chronic heart failure;
- Thromboembolic complications;
- Cardiovascular complications related to COVID-19 therapies [3].

Electrocardiography (ECG) is one of the basic diagnostic tests performed in hospitalized COVID-19 patients. Due to its wide availability and low cost, it is useful in the initial evaluation of COVID-19 patients with a history of cardiovascular disease, and patients with suspected cardiovascular complications in the course of the infection. Since the beginning of the COVID-19 pandemic, numerous reports

Address for correspondence: Patryk Siedlecki MD, Katedra i I Klinika Kardiologii, Uniwersytet Medyczny w Łodzi, Wojewódzki Specjalistyczny Szpital im. dra W. Biegańskiego, ul. Kniaziewicza 1/5, 91–347 Łódź, Poland, phone +48 42 251 62 16, e-mail: patricks7@wp.pl

have been published on ECG changes in infected patients. These analyses and observations highlight the complexity and diversity of these changes, indicating a need for further studies looking for changes specific for COVID-19. Below, we report the types and characteristics of ECG changes reported by different authors.

P wave changes and atrioventricular conduction disturbances

P waves should be evaluated when analysing an ECG in a patient with COVID-19.

Yenerçağ et al. [4] evaluated P wave changes in 140 patients with newly diagnosed SARS-CoV-2, comparing their results to a gender- and age-matched control group. In the study group, an increased P wave dispersion was found that correlated with serum C-reactive protein (CRP) level. During further follow-up with the mean duration of 14 days, new-onset atrial fibrillation was noted in 13 (9.3%) of patients infected with SARS-CoV-2. Eleven patients in the latter subgroup required admission to an intensive care unit (ICU) [4].

Amaratunga et al. [5] reported a series of 4 patients with no history of bradyarrhythmia admitted to an intensive care unit, in whom transient sinus bradycardia with the minimal heart rate of 42-49 beats per minute (bpm) was observed during the hospitalization. Their heart rate on admission ranged from 66 to 88 bpm [5]. Babapoor-Farrokhran et al. [6] reported two female patients with COVID-19. One of them was a 69-year-old woman with a history of hypertension and diabetes type 2, in whom sinus rhythm with the rate of 78 bpm was noted in an ECG recorded on admission but transient 2:1 second degree atrioventricular block with the QRS rate of 40 bpm was observed during the hospitalization. The patient reported no symptoms associated with conduction disturbances. The other patient was an 89-year-old woman with a history of hypertension in whom sinus rhythm with the rate of 85 bpm and the evidence of left ventricular hypertrophy were noted in the baseline ECG. On the eight day of hospital stay, pauses up to 5.3 seconds due to sinus arrest were recorded during ECG monitoring. Over the next days, shorter pauses up to 2-3 seconds were observed, with their complete resolution by the tenth day of hospital stay [6].

QRS complex changes

Bertini et al. [7] analysed ECGs recorded on admission in 431 critically ill COVID-19 patients (hospitalization resulting in death or a need for mechanical ventilation). Changes suggesting an acute right ventricular pressure overload (RVPO) were noted in 130 (30%) patients, including the S1Q3T3 pattern in 43 (10%) patients, incomplete right bundle branch block (iRBBB) in 38 (9%) patients, and complete right bundle branch block (RBBB) in 49 (11%) patients [7].

In their study, Abrams et al. [8] included 133 patients with confirmed SARS-CoV-2 infection who died during the hospitalization. The most common changes noted in ECG on admission included cardiac axis deviation (25.8%) and RBBB (11.9%). Death due to cardiac arrhythmia occurred in 11 (8.3%) cases, and left bundle branch block (LBBB) and prolongation of corrected QT (QTc) interval were more frequently noted in baseline ECGs in this patient group [8].

Yıldırım et al. [9] analysed ECGs in patients with confirmed SARS-CoV-2 for the presence of fragmented QRS (fQRS). The study included 114 patients. ECG showed fQRS in 42 (36.8%) patients, and this group was characterized by a significantly longer duration of hospital stay, higher rate of admission to an intensive care unit, and higher all-cause and cardiovascular mortality. Longer QRS duration correlated with the length of hospital stay and showed an association with the need for admission to an intensive care unit, and all-cause and cardiovascular mortality [9].

ST-T changes

Li et al. [10] evaluated 135 hospitalized patients at the mean age of 64 years. The most commonly noted ECG abnormalities were ST-T changes, present in 40% of patients. Of all patients included in the analysis, 23 (17.0%) required admission to an intensive care unit. Significantly more common ECG findings in this group included ST-T changes, pathological Q wave, and QTc interval prolongation. A follow-up ECG during the hospitalization was recorded in 27 patients and new abnormalities were identified in 17 of them. Statistical analysis showed that ST-T changes in the admission ECG and a history of cardiovascular disease were associated with a significantly higher risk of admission to an ICU [10]. Angeli et al. [11] also noted frequent ST-T changes in COVID-19 patients. In their study, ST-T changes were present in the admission ECG in 30% of patients.

Wang et al. [12] analysed the characteristics of COVID-19 patients in relation to the clinical course of the disease. The study included 319 patients. Of these, 97 patients were critically ill, and the disease was severe in 222 patients. Among critically ill patients, ST-T changes, sinus tachycardia, atrial fibrillation, and atrial tachycardia were significantly more common compared to the patients with severe disease. Elevated troponin I and N-terminal pro-B-type natriuretic peptide (NT-proBNP) levels were independent predictors of ST-T changes in ECG [12, 13].

QTc interval changes

QTc interval prolongation has been frequently reported in COVID-19. Its occurrence has been noted in the previously cited study by Li et al. [10]. Chen et al. [14] analysed the clinical course of the disease in 63 hospitalized patients

with a confirmed SARS-CoV-2 infection. Tests performed during the hospitalization included a standard 12-lead ECG and serum markers of myocardial damage (high-sensitivity troponin I, myoglobin, and creatine kinase isoform MB [CK-MB]). The patients were divided into groups with or without evidence of myocardial damage depending on whether an elevated serum level of at least one of the above biomarkers was identified. Overall, evidence of myocardial damage was found in 23 patients and this group was characterized by an increased mortality, and higher rates of QTc interval prolongation and T wave changes on ECG. In addition, QTc interval duration was found to be an independent predictor of myocardial damage, and the presence of T wave changes was an independent predictor of mortality [14].

Öztürk et al. [15] compared ECG parameters in 51 hospitalized COVID-19 patients and 40 age- and gender-matched controls. A significantly higher mean QTc interval duration was found in COVID-19 patients (410.8 ± 24.3 ms vs. 394.6 ± 20.3 ms, $p < 0.001$) [15].

QTc interval changes in COVID-19 patients should be always interpreted in the context of medications taken by the patients. In the study by van den Broek et al. [16], ECG changes were analysed in 95 patients receiving chloroquine for COVID-19. ECG was recorded at baseline and during treatment. Statistical analysis showed that the mean QTc interval prolongation was 35 ms. During the therapy, QTc interval increased to above 500 ms in 22 (23%) patients [16].

Previous therapeutic uses of chloroquine have included the treatment of malaria, systemic lupus erythematosus and rheumatoid arthritis. An anti-inflammatory effect and an *in vitro* antiviral effect have been noted among its key mechanisms of action. Use of chloroquine for the treatment of COVID-19 has been enthusiastically welcomed, with promising early reports of the treatment results. However, further studies did not confirm the expected benefits of chloroquine [17, 18].

Cardiac arrhythmia

Bhatla et al. [19] evaluated the incidence of cardiac arrhythmia in hospitalized COVID-19 patients. The study included 700 patients at the mean age of 50 ± 18 years. Admission to an intensive care unit was required in 11% of these patients. Over the course of the hospitalization, 53 episodes of new-onset arrhythmia were recorded, include 25 episodes of atrial fibrillation and 10 episodes on non-sustained ventricular tachycardia. In addition, 9 cardiac arrest events occurred, including 6 episodes of pulseless electrical activity, 2 episodes of asystole, and 1 episode of torsade de pointes. In statistical analysis, admission to an intensive care unit was associated with the occurrence of atrial fibrillation and non-sustained ventricular tachycardia episodes [19].

The analysis in a multicentre study by Coromilas et al. [20] included 4526 hospitalized patients with a confirmed SARS-CoV-2 infection. During the hospitalization, new-onset arrhythmia occurred in 827 patients. The mean age of this subgroup was 71.1 ± 14.1 years, higher compared to the mean age of the overall study population (62.8 ± ± 17.0 years). A history of cardiovascular disease was relatively frequent in this subgroup, with hypertension in 69%, heart failure in 30%, and coronary artery disease in 24%. Most patients with episode of arrhythmia during the hospitalization had no previous history of cardiac arrhythmia. In statistical analysis, episode of arrhythmia was associated with a significantly increased mortality rate. Of all patients with new-onset arrhythmia, 43% required mechanical ventilation, and only 51% survived until the hospital discharge. The most commonly recorded type of arrhythmia was atrial arrhythmia (81.8%), mainly atrial fibrillation and flutter. The incidence of ventricular arrhythmia was 21%, most commonly ventricular tachycardia (both sustained and non-sustained) and ventricular fibrillation [20]. In the study by Gopinathannair et al. [21] among hospitalized COVID-19 patients, the incidence of atrial fibrillation was 21%, of atrial flutter 5.4%, and of atrial tachycardia 5.7%. Ventricular arrhythmias were less common: the rates were 5.3% for monomorphic premature beats, 3.5% for polymorphic premature beats, 6.3% for non-sustained ventricular tachycardia, 3.8% for sustained monomorphic ventricular tachycardia, 3.5% for polymorphic ventricular tachycardia/*torsade de pointes*, and 4.8% for ventricular fibrillation [21].

Changes in ECG related to pulmonary embolism

Pulmonary embolism is a major complication of COVID-19, particularly in severely ill patients. Postulated mechanisms of an increased risk of venous thrombosis in COVID-19 include an increased activity of angiotensin II and related clotting system and platelet activation, cytokine-mediated activation of the clotting cascade, and a potential effect of the viral infection itself leading to local inflammation and focal thrombosis. Regarding the ECG findings in the acute phase of the disease, sinus tachycardia and atrial fibrillation with rapid ventricular response, as well as the evidence of right ventricular overload have been commonly reported. Other reported findings include negative T waves in the anterior wall leads and RBBB.

Kho et al. [22] reported a series of 15 pulmonary embolism cases in COVID-19 patients. Sinus tachycardia developed in 7 (47%) patients, and the evidence of right ventricular overload was present in 5 (33%) patients. The S1Q3T3 pattern on ECG was identified in only one patient [23, 24].

Table 1. Most common electrocardiogram changes in patients with coronavirus disease 2019

P wave and AV conduction disturbances	QRS complexes	Changes in the repolarization period	Cardiac arrhythmia
Increased P wave dispersion	Evidence of RVPO	ST-T changes	Atrial fibrillation and flutter
Sinus bradycardia	Intraventricular conduction disturbances	QTc interval prolongation	Ventricular arrhythmia
AV block	QRS complex fragmentation		

AV — atrioventricular; RVPO — right ventricular pressure overload

Summary

Electrocardiographic findings seen in COVID-19 patients may include P wave and atrioventricular conduction abnormalities, QRS complex alterations including their fragmentation, evidence of right ventricular overload, ST-T changes, and QTc interval prolongation (Table 1). The most common cardiac arrhythmias are supraventricular arrhythmias, particularly atrial fibrillation. These results are consistent with the authors' own observations. In our material, atrial fibrillation/flutter was present in 26% of patients, atrioventricular block in 13% of patients, intraventricular conduction disturbances in 26% of patients, ST-T changes in 48% of patients, and QTc interval prolongation in 46% of patients. Of note, none of the above changes are specific for SARS-CoV-2 infection, and precise determination of their prognostic value would require more studies to be performed in adequately large patient samples.

Conflict of interest

The authors declare no conflict of interests.

Funding

None.

References

1. Medycyna Praktyczna [Internet]. Interna. Dodatkowe materiały. COVID-19 (choroba spowodowana przez SARS-CoV-2). 07.04.2021. https://www.mp.pl/interna/chapter/B01.XI.C.18.1 (7.06.2021).
2. Long B, Brady WJ, Bridwell RE, et al. Electrocardiographic manifestations of COVID-19. Am J Emerg Med. 2021; 41: 96–103, doi: 10.1016/j.ajem.2020.12.060, indexed in Pubmed: 33412365.
3. Madjid M, Safavi-Naeini P, Solomon SD, et al. Potential effects of coronaviruses on the cardiovascular system: a review. JAMA Cardiol. 2020; 5(7): 831–840, doi: 10.1001/jamacardio.2020.1286, indexed in Pubmed: 32219363.
4. Yenerçağ M, Arslan U, Şeker OO, et al. Evaluation of P-wave dispersion in patients with newly diagnosed coronavirus disease 2019. J Cardiovasc Med (Hagerstown). 2021; 22(3): 197–203, doi: 10.2459/JCM.0000000000001135, indexed in Pubmed: 33186236.
5. Amaratunga EA, Corwin DS, Moran L, et al. Bradycardia in patients with COVID-19: a calm before the storm? Cureus. 2020; 12(6): e8599, doi: 10.7759/cureus.8599, indexed in Pubmed: 32550090.
6. Babapoor-Farrokhran S, Batnyam U, Wiener PC, et al. Atrioventricular and sinus node dysfunction in stable COVID-19 patients. SN Compr Clin Med. 2020 [Epub ahead of print]: 1–4, doi: 10.1007/s42399-020-00497-5, indexed in Pubmed: 32901230.
7. Bertini M, Ferrari R, Guardigli G, et al. Electrocardiographic features of 431 consecutive, critically ill COVID-19 patients: an insight into the mechanisms of cardiac involvement. Europace. 2020; 22(12): 1848–1854, doi: 10.1093/europace/euaa258, indexed in Pubmed: 32944767.
8. Abrams MP, Wan EY, Waase MP, et al. Clinical and cardiac characteristics of COVID-19 mortalities in a diverse New York City Cohort. J Cardiovasc Electrophysiol. 2020; 31(12): 3086–3096, doi: 10.1111/jce.14772, indexed in Pubmed: 33022765.
9. Yildirim A, Karaca IO, Yilmaz FK, et al. Fragmented QRS on surface electrocardiography as a predictor of cardiac mortality in patients with SARS-CoV-2 infection. J Electrocardiol. 2021; 66: 108–112, doi: 10.1016/j.jelectrocard.2021.03.001, indexed in Pubmed: 33906057.
10. Li Y, Liu T, Tse G, et al. Electrocardiograhic characteristics in patients with coronavirus infection: a single-center observational study. Ann Noninvasive Electrocardiol. 2020; 25(6): e12805, doi: 10.1111/anec.12805, indexed in Pubmed: 32951285.
11. Angeli F, Spanevello A, De Ponti R, et al. Electrocardiographic features of patients with COVID-19 pneumonia. Eur J Intern Med. 2020; 78: 101–106, doi: 10.1016/j.ejim.2020.06.015, indexed in Pubmed: 32586646.
12. Wang Y, Chen L, Wang J, et al. Electrocardiogram analysis of patients with different types of COVID-19. Ann Noninvasive Electrocardiol. 2020; 25(6): e12806, doi: 10.1111/anec.12806, indexed in Pubmed: 32951316.
13. World Health Organization. COVID-19 clinical management: living guidance 25 January 2021.
14. Chen L, Feng Yi, Tang J, et al. Surface electrocardiographic characteristics in coronavirus disease 2019: repolarization abnormalities associated with cardiac involvement. ESC Heart Fail. 2020; 7(6): 4408–4415, doi: 10.1002/ehf2.12991, indexed in Pubmed: 32898341.
15. Öztürk F, Karaduman M, Çoldur R, et al. Interpretation of arrhythmogenic effects of COVID-19 disease through ECG. Aging Male. 2020; 23(5): 1362–1365, doi: 10.1080/13685538.2020.1769058, indexed in Pubmed: 32449420.
16. van den Broek MPH, Möhlmann JE, Abeln BGS, et al. Chloroquine-induced QTc prolongation in COVID-19 patients. Neth Heart J. 2020; 28(7-8): 406–409, doi: 10.1007/s12471-020-01429-7, indexed in Pubmed: 32350818.

17. Carafoli E. Chloroquine and hydroxychloroquine in the prophylaxis and therapy of COVID-19 infection. Biochem Biophys Res Commun. 2021; 538: 156–162, doi: 10.1016/j.bbrc.2020.09.128, indexed in Pubmed: 33028485.
18. Shah RR. Chloroquine and hydroxychloroquine for COVID-19: perspectives on their failure in repurposing. J Clin Pharm Ther. 2021; 46(1): 17–27, doi: 10.1111/jcpt.13267, indexed in Pubmed: 32981089.
19. Bhatla A, Mayer MM, Adusumalli S, et al. COVID-19 and cardiac arrhythmias. Heart Rhythm. 2020; 17(9): 1439–1444, doi: 10.1016/j.hrthm.2020.06.016, indexed in Pubmed: 32585191.
20. Coromilas EJ, Kochav S, Goldenthal I, et al. Worldwide survey of COVID-19-associated arrhythmias. Circ Arrhythm Electrophysiol. 2021; 14(3): e009458, doi: 10.1161/CIRCEP.120.009458, indexed in Pubmed: 33554620.
21. Gopinathannair R, Merchant FM, Lakkireddy DR, et al. COVID-19 and cardiac arrhythmias: a global perspective on arrhythmia characteristics and management strategies. J Interv Card Electrophysiol. 2020; 59(2): 329–336, doi: 10.1007/s10840-020-00789-9, indexed in Pubmed: 32494896.
22. Kho J, Ioannou A, Van den Abbeele K, et al. Pulmonary embolism in COVID-19: Clinical characteristics and cardiac implications. Am J Emerg Med. 2020; 38(10): 2142–2146, doi: 10.1016/j.ajem.2020.07.054, indexed in Pubmed: 33046316.
23. Middeldorp S, Coppens M, van Haaps TF, et al. Incidence of venous thromboembolism in hospitalized patients with COVID-19. J Thromb Haemost. 2020; 18(8): 1995–2002, doi: 10.1111/jth.14888, indexed in Pubmed: 32369666.
24. Avila J, Long B, Holladay D, et al. Thrombotic complications of COVID-19. Am J Emerg Med. 2021; 39: 213–218, doi: 10.1016/j.ajem.2020.09.065, indexed in Pubmed: 33036855.

Folia Cardiologica 2022
tom 17, nr 1, strony 40–44

ISSN 2353–7752
e-ISSN 2353–7760

Zmiany w elektrokardiogramie u pacjentów z COVID-19

Patryk Siedlecki, Małgorzata Kurpesa

Katedra i I Klinika Kardiologii Uniwersytetu Medycznego w Łodzi

Artykuł jest tłumaczeniem pracy: Siedlecki P, Kurpesa M. Electrocardiographic changes in patients with COVID-19. 2021; 17(1): 35–39. DOI: 10.5603/FC.2022.0005. Należy cytować wersję pierwotną

Streszczenie

Elektrokardiografia jest jednym z podstawowych badań wykonywanych u pacjentów hospitalizowanych z powodu choroby koronawirusowej 2019 (COVID-19, *coronavirus disease 2019*). Duża dostępność oraz niski koszt wykonania badania sprawiają, że jest użyteczne we wstępnej ocenie zakażonych pacjentów z chorobami układu krążenia w wywiadzie, jak również chorych z podejrzeniem wystąpienia powikłań sercowo-naczyniowych w przebiegu zakażenia. Zmiany w elektrokardiogramie (EKG) obserwowane u chorych na COVID-19 mogą dotyczyć różnych elementów krzywej EKG: od zaburzeń dotyczących załamka P oraz przewodzenia przedsionkowo-komorowego, poprzez zmiany zespołów QRS obejmujące ich fragmentację oraz cechy przeciążenia prawej komory serca, zmiany ST-T, aż do wydłużenia odstępu QTc. Wśród zaburzeń rytmu serca najczęściej stwierdza się arytmie nadkomorowe, zwłaszcza migotanie przedsionków.

Słowa kluczowe: EKG, elektrokardiogram, COVID-19, SARS-CoV-2, zaburzenia rytmu serca

Folia Cardiologica 2022; 17, 1: 40–44

Wstęp

Choroba koronawirusowa 2019 (COVID-19, *coronavirus disease 2019*) to choroba zakaźna, której czynnikiem etiologicznym jest koronawirus zespołu ostrej niewydolności oddechowej 2 (SARS-CoV-2, *severe acute respiratory syndrome coronavirus 2*) — wirus RNA, należący do beta-koronawirusów. Jego rezerwuarem są zakażone osoby, natomiast jest przenoszony drogą wziewną, głównie kropelkową, ale prawdopodobnie również powietrzną oraz kontaktową. Receptorem wykorzystywanym przez wirusa w celu wniknięcia do komórki jest konwertaza angiotensyny typu 2 (ACE2, *angiotensin-converting enzyme 2*). Okres inkubacji wynosi od 2 do 14 dni, jednak może być wydłużony nawet do 27 dni. Przebieg kliniczny zakażenia może być bezobjawowy, mogą również występować nieswoiste objawy, między innymi obniżona lub podwyższona temperatura ciała, osłabienie, kaszel, nieżyt nosa, zaburzenia węchu i smaku, ból głowy. W niektórych przypadkach dochodzi do rozwoju zapalenia płuc, a nawet zespołu ostrej niewydolności oddechowej (ARDS, *acute respiratory distress syndrome*) lub sepsy. W ciężkich postaciach choroby w patomechanizmie ważną rolę odgrywa reakcja układu immunologicznego na antygeny wirusa. Dochodzi do uwolnienia cytokin prozapalnych i chemokin, co daje obraz ogólnoustrojowej reakcji zapalnej, tak zwanej burzy cytokinowej [1].

Chociaż cięższe postacie COVID-19 dotyczą głównie układu oddechowego, to istotne są również powikłania ze strony układu krążenia. Ponadto pacjenci z chorobami układu sercowo-naczyniowego w wywiadzie są narażeni na zwiększone ryzyko ciężkiego przebiegu zakażenia [1, 2].

Adres do korespondencji: lek. Patryk Siedlecki, Katedra i I Klinika Kardiologii, Uniwersytet Medyczny w Łodzi, Wojewódzki Specjalistyczny Szpital im. dra W. Biegańskiego, ul. Kniaziewicza 1/5, 91–347 Łódź, tel. +48 42 251 62 16, e-mail: patricks7@wp.pl

Powikłania sercowo-naczyniowe związane z COVID-19 można podzielić na 5 kategorii:

- uszkodzenie mięśnia sercowego (związane z niedokrwieniem lub zapaleniem mięśnia sercowego);
- zaburzenia rytmu serca;
- nowo rozpoznana niewydolność serca lub zaostrzenie przewlekłej niewydolności serca;
- powikłania zakrzepowo-zatorowe;
- powikłania sercowo-naczyniowe związane ze stosowanym leczeniem [3].

Elektrokardiografia (EKG) jest jednym z podstawowych badań wykonywanych u hospitalizowanych pacjentów z COVID-19. Wysoka dostępność badania oraz niski koszt jego wykonania sprawiają, że jest użyteczne we wstępnej ocenie zakażonych pacjentów z chorobami układu krążenia w wywiadzie, jak również chorych z podejrzeniem wystąpienia powikłań sercowo-naczyniowych w przebiegu zakażenia. Od początku pandemii COVID-19 opublikowano wiele doniesień dotyczących zmian w EKG u zakażonych pacjentów. W przeprowadzonych analizach i obserwacjach podkreśla się złożoność i różnorodność tych zmian, co wskazuje na konieczność przeprowadzenia wielu badań w celu poszukiwania zmian specyficznych dla COVID-19. Poniżej przedstawiono rodzaj i charakterystykę zaobserwowanych przez wielu autorów zmian.

Zmiany załamka P oraz zaburzenia przewodzenia przedsionkowo-komorowego

Analizując zapis EKG pacjenta z COVID-19, warto zwrócić uwagę na załamki P.

Yenerçağ i wsp. [4] oceniali zmiany załamka P w zapisie EKG u 140 pacjentów ze świeżo rozpoznanym zakażeniem SARS-CoV-2, a uzyskane rezultaty porównywali z wynikami uzyskanymi w dopasowanej według płci i wieku grupie kontrolnej. W grupie badanej zaobserwowano zwiększoną dyspersję załamka P, której wartość korelowała ze stężeniam białka C-reaktywnego (CRP, *C-reactive protein*) w surowicy. W dalszej obserwacji o średnim czasie trwania 14 dni u 13 (9,3%) pacjentów zakażonych SARS-CoV-2 stwierdzono migotanie przedsionków rozpoznane po raz pierwszy. Jedenastu chorych z tej podgrupy wymagało leczenia na oddziale intensywnej terapii (OIT) [4].

Amaratunga i wsp. [5] opisali serię przypadków 4 pacjentów przyjętych na OIT, u których w trakcie hospitalizacji obserwowano przemijające okresy bradykardii zatokowej z minimalną częstotliwością rytmu serca w zakresie 42–49/min. Częstotliwość rytmu serca przy przyjęciu wynosiła od 66/min do 88/min. U żadnego z pacjentów nie stwierdzono w wywiadzie wcześniejszych (przed przyjęciem do szpitala) epizodów bradyarytmii [5]. Babapoor-Farrokhran i wsp. [6] opisali dwie pacjentki z COVID-19. Pierwsza z nich to 69-letnia kobieta z nadciśnieniem tętniczym i cukrzycą typu 2 w wywiadzie, u której w zapisie EKG przy przyjęciu zarejestrowano rytm zatokowy o częstotliwości 78/min. W trakcie hospitalizacji obserwowano przemijający blok przedsionkowo-komorowy II stopnia 2:1 z częstotliwością zespołów QRS 40/min. Pacjentka nie zgłaszała objawów związanych z zaburzeniami przewodzenia. Drugi z opisanych przypadków dotyczył 83-letniej pacjentki z nadciśnieniem tętniczym w wywiadzie, u której w wyjściowym zapisie EKG odnotowano rytm zatokowy o częstotliwości 85/min oraz cechy przerostu lewej komory. W ósmym dniu hospitalizacji w monitorowaniu EKG rejestrowano pauzy do 5,3 s powstałe w mechanizmie zahamowań zatokowych. W kolejnych dniach obserwowano stopniowe ustępowanie zaburzeń z pauzami do 2–3 s, natomiast dziesiątego dnia hospitalizacji powyższe zmiany ustąpiły całkowicie.

Zmiany dotyczące zespołów QRS

Bertini i wsp. [7] analizowali zapisy EKG wykonane przy przyjęciu u 431 pacjentów z COVID-19 w stanie krytycznym (hospitalizacja zakończona zgonem lub konieczność zastosowania wentylacji mechanicznej). U 130 (30%) pacjentów stwierdzono zmiany sugerujące ostre przeciążenie ciśnieniowe prawej komory: 43 (10%) przypadki obecności zespołu S1Q3T3, 38 (9%) przypadków niepełnego bloku prawej odnogi pęczka Hisa (iRBBB, *incomplete right bundle branch block*) oraz 49 (11%) przypadków bloku prawej odnogi pęczka Hisa (RBBB, *right bundle branch block*) [7].

Abrams i wsp. [8] do swojego badania włączyli 133 pacjentów z potwierdzonym zakażeniem SARS-CoV-2, których hospitalizacja zakończyła się zgonem. Najczęściej stwierdzane zaburzenia w EKG przy przyjęciu obejmowały między innymi: odchylenia osi elektrycznej serca (25,8%) oraz RBBB (11,9%). Zgon z powodu zaburzeń rytmu serca wystąpił w 11 (8,3%) przypadkach — w tej grupie pacjentów w wyjściowym zapisie EKG częściej obserwowano blok lewej odnogi pęczka Hisa (LBBB, *left bundle branch block*) oraz wydłużony odstęp QTc [8].

Yıldırım i wsp. [9] analizowali zapisy EKG pacjentów z potwierdzonym zakażeniem SARS-CoV-2 pod kątem fragmentacji zespołów QRS (fQRS, *fragmented QRS*). Do badania włączono 114 chorych. W EKG u 42 (36,8%) pacjentów stwierdzono fQRS — w tej grupie czas hospitalizacji był istotnie dłuższy, częstość hospitalizacji na OIT większa, a śmiertelność z jakiejkolwiek przyczyny oraz z przyczyn sercowo-naczyniowych wyższa. Dłuższy czas trwania zespołów QRS korelował z czasem trwania hospitalizacji, ponadto był związany z koniecznością hospitalizacji na OIT oraz śmiertelnością z jakiejkolwiek przyczyny oraz z przyczyn sercowo-naczyniowych [9].

Zmiany odcinka ST oraz załamka T

Li i wsp. [10] włączyli do analizy 135 hospitalizowanych pacjentów w średnim wieku 64 lat. Zmiany ST-T były najczęściej stwierdzanymi zaburzeniami w EKG i występowały u 40% chorych. Spośród wszystkich pacjentów poddanych analizie 23 (17%) wymagało leczenia w OIT. W tej grupie istotnie częściej występowały zmiany ST-T, patologiczne załamki Q, jak również wydłużenie odstępu QTc. Dwudziestu siedmiu chorym wykonano kontrolną rejestrację EKG w trakcie hospitalizacji i u 17 z nich stwierdzono obecność nowych odchyleń. W analizie statystycznej zmiany ST-T w EKG przy przyjęciu oraz choroby układu sercowo-naczyniowego w wywiadzie były związane z istotnie wyższym ryzykiem konieczności leczenia w ramach OIT [10]. Również Angeli i wsp. [11] obserwowali częste występowanie zmian ST-T u chorych z COVID-19. W wykonanym przy przyjęciu EKG zmiany ST-T występowały u 30% obserwowanych pacjentów.

Wang i wsp. [12] analizowali parametry pacjentów z COVID-19 w odniesieniu do przebiegu klinicznego choroby. Do badania włączono 319 chorych. Krytyczny przebieg choroby wystąpił u 97 pacjentów, natomiast ciężki — u 222. Wśród pacjentów z krytycznym przebiegiem zakażenia zmiany ST-T, tachykardię zatokową, migotanie przedsionków oraz częstoskurcz przedsionkowy obserwowano istotnie częściej niż w grupie z ciężkim przebiegiem zakażenia. Podwyższone stężenia troponiny I oraz N-końcowego fragmentu propeptydu natriuretycznego typu B w badaniach laboratoryjnych stanowił niezależny czynnik ryzyka obecności zmian ST-T w EKG [12, 13].

Zmiany odstępu QTc

Wydłużenie odstępu QTc jest zjawiskiem często opisywanym w przebiegu COVID-19. Na jego występowanie zwrócono uwagę we wspomnianej wcześniej pracy Li i wsp. [10] Natomiast Chen i wsp. [14] analizowali przebieg kliniczny 63 hospitalizowanych pacjentów z potwierdzonym zakażeniem SARS-CoV-2. W trakcie hospitalizacji wykonano między innymi standardowe 12-odprowadzeniowe badanie EKG oraz oznaczenia stężenia markerów uszkodzenia miokardium w surowicy (troponiny I za pomocą testu o wysokiej czułości oraz mioglobiny, izoformy sercowej kinazy kreatynowej). Pacjentów podzielono na grupy z cechami i bez cech uszkodzenia mięśnia sercowego w zależności od tego, czy stwierdzono podwyższone stężenie w surowicy co najmniej jednego z powyższych biomarkerów. Dwudziestu trzech chorych miało cechy uszkodzenia mięśnia sercowego. W tej grupie obserwowano większą śmiertelność, natomiast w zapisie EKG częściej stwierdzano wydłużenie odstępu QTc oraz zmiany załamka T. Ponadto czas trwania odstępu QTc był niezależnym wskaźnikiem uszkodzenia mięśnia sercowego, natomiast obecność zmian załamka T stanowiła niezależny predyktor zgonu [14].

Öztürk i wsp. [15] porównywali parametry EKG 51 hospitalizowanych pacjentów z COVID-19 z 40 dopasowanymi względem wieku i płci uczestnikami stanowiącymi grupę kontrolną. W grupie chorych z COVID-19 stwierdzono istotnie wyższą średnią wartość odstępu QTc (410,8 ± 24,3 ms *vs.* 394,6 ± 20,3 ms; $p < 0{,}001$) [15].

Zmiany odstępu QTc u pacjentów z COVID-19 należy zawsze interpretować, biorąc pod uwagę przyjmowane przez pacjenta leki. W badaniu van den Broek i wsp. [16] analizowano zmiany w EKG u 95 pacjentów leczonych chlorochiną w ramach terapii COVID-19. Rejestrację EKG wykonywano przed rozpoczęciem leczenia oraz w jego trakcie. W wyniku analizy statystycznej stwierdzono średnie wydłużenie odstępu QTc o 35 ms. W trakcie terapii u 22 (23%) pacjentów nastąpiło wydłużenie odstępu QTc do wartości przekraczających 500 ms [16].

Chlorochina była dotychczas stosowana między innymi w leczeniu malarii, tocznia rumieniowatego układowego oraz reumatoidalnego zapalenia stawów. Wśród kluczowych mechanizmów jej działania wskazywano efekt przeciwzapalny oraz przeciwwirusowy w badaniach *in vitro*. Początkowo jej zastosowanie w leczeniu COVID-19 wzbudziło entuzjazm, a wstępne doniesienia o wynikach terapii były obiecujące. Jednak w kolejnych badaniach nie potwierdzono spodziewanych korzyści z jej stosowania [17, 18].

Zaburzenia rytmu serca

Bhatla i wsp. [19] oceniali częstość występowania zaburzeń rytmu serca u hospitalizowanych pacjentów z COVID-19. Do badania włączyli 700 chorych w średnim wieku 50 ± 18 lat. Leczenia na OIT wymagało 11% chorych z tej grupy. W trakcie hospitalizacji zarejestrowano 53 epizody nowych zaburzeń rytmu, w tym 25 epizodów migotania przedsionków oraz 10 epizodów nieutrwalonego częstoskurczu komorowego. Ponadto wystąpiło 9 przypadków nagłego zatrzymania krążenia: 6 z nich w mechanizmie aktywności elektrycznej bez tętna (PEA, *pulseless electrical activity*), 2 przypadki asystolii oraz 1 przypadek *torsade de pointes*. W analizie statystycznej przyjęcie na OIT było związane z epizodem migotania przedsionków oraz nieutrwalonego częstoskurczu komorowego [19].

W wieloośrodkowym badaniu Coromilas i wsp. [20] do analizy włączono 4526 hospitalizowanych pacjentów z potwierdzonym zakażeniem SARS-CoV-2. Podczas pobytu w szpitalu nowe zaburzenia rytmu serca pojawiły się u 827 chorych. Średnia wieku wynosiła 71,1 ± 14,1 roku i była wyższa niż średnia wieku całej badanej populacji (62,8 ± 17,0). Dość często w tej podgrupie występowały choroby układu sercowo-naczyniowego: nadciśnienie tętnicze u 69%, niewydolność serca u 30% oraz choroba

Tabela 1. Najczęściej spotykane zmiany w elektrokardiogramie u pacjentów z chorobą koronawirusową 2019

Załamek P i zaburzenia przewodzenia AV	Zespoły QRS	Zmiany okresu repolaryzacji	Zaburzenia rytmu
Zwiększona dyspersja załamka P	Cechy RVPO	Zmiany ST-T	Migotanie i trzepotanie przedsionków
Bradykardia zatokowa	Zaburzenia przewodzenia śródkomorowego	Wydłużenie odstępu QTc	Komorowe zaburzenia rytmu
Blok przedsionkowo-komorowy	Fragmentacja zespołów QRS		

AV (*atrioventricular*) — przedsionkowo-komorowe; RVPO (*right ventricular pressure overload*) — przeciążenie ciśnieniowe prawej komory

wieńcowa u 24%. U większości pacjentów, u których w trakcie hospitalizacji wystąpiła arytmia, nie stwierdzono wcześniejszego wywiadu zaburzeń rytmu serca. W analizie statystycznej wystąpienie zaburzeń rytmu było związane z istotnym wzrostem śmiertelności. Wentylacji mechanicznej wymagało 43% pacjentów z nową arytmią, zaś tylko 51% przeżyło do czasu wypisania ze szpitala. Wśród zaburzeń rytmu najczęściej rejestrowano arytmie przedsionkowe (81,8%), w tym głównie migotanie i trzepotanie przedsionków. Częstość występowania komorowych zaburzeń rytmu serca wynosiła 21%. Najczęściej obserwowano częstoskurcze komorowe (utrwalone i nieutrwalone) oraz migotanie komór [20]. W badaniu Gopinathannair i wsp. [21] wśród hospitalizowanych pacjentów z COVID-19 częstość migotania przedsionków wynosiła 21%, trzepotania przedsionków 5,4%, natomiast częstoskurczu przedsionkowego 5,7%. Arytmie komorowe występowały rzadziej: 5,3% przypadków stanowiły monomorficzne pobudzenia przedwczesne; 3,5% polimorficzne pobudzenia przedwczesne; 6,3% nieutrwalone częstoskurcze komorowe; 3,8% utrwalone monomorficzne częstoskurcze komorowe; 3,5% polimorficzne częstoskurcze komorowe/*torsade de pointes*; natomiast 4,8% migotanie komór [21].

Zmiany w EKG związane z zatorowością płucną

Zatorowość płucna jest jednym z poważniejszych powikłań w przebiegu COVID-19, zwłaszcza wśród pacjentów w ciężkim stanie. Proponowane w piśmiennictwie mechanizmy prowadzące do zwiększonej tendencji do zakrzepicy żylnej w COVID-19 to między innymi zwiększona aktywność angiotensyny II i związana z nią aktywacja układu krzepnięcia krwi oraz funkcji płytek krwi, aktywacja kaskady krzepnięcia za pośrednictwem cytokin, jak również potencjalny efekt samej infekcji wirusowej prowadzący do miejscowego procesu zapalnego i ogniskowej zakrzepicy. Jeśli chodzi o obraz EKG, to w ostrej fazie choroby opisywano częste występowanie tachykardii zatokowej oraz migotania przedsionków z szybką odpowiedzią rytmu komór, jak również cech przeciążenia prawej komory. Obserwowano również ujemne załamki T w odprowadzeniach znad ściany przedniej oraz RBBB.

Kho i wsp. [22] opisali serię 15 przypadków zatorowości płucnej u chorych na COVID-19. Tachykardia zatokowa wystąpiła u 7 (47%) pacjentów, natomiast zmiany sugerujące przeciążenie prawej komory u 5 (33%) chorych. Tylko u jednego pacjenta w EKG był obecny zespół S1Q3T3 [23, 24].

Podsumowanie

Zmiany w EKG obserwowane u chorych na COVID-19 mogą dotyczyć różnych elementów krzywej EKG: od zaburzeń dotyczących załamka P oraz przewodzenia przedsionkowo-komorowego, poprzez zmiany zespołów QRS obejmujące ich fragmentację oraz cechy przeciążenia prawej komory serca, zmiany ST-T, aż do wydłużenia odstępu QTc (tab. 1). Wśród zaburzeń rytmu serca najczęściej stwierdza się arytmie nadkomorowe, zwłaszcza migotanie przedsionków. Powyższe wyniki są zgodne z obserwacjami uzyskanymi na podstawie materiału własnego autorów niniejszej pracy. Migotanie/trzepotanie przedsionków występowało u 26% pacjentów, blok przedsionkowo-komorowy u 13%, zaburzenia przewodzenia śródkomorowego u 26%, zmiany ST-T u 48%, natomiast wydłużenie odstępu QTc u 46%. Należy jednak pamiętać, że żadne z powyższych zmian nie są swoiste dla zakażenia SARS-CoV-2, a jednoznaczne określenie ich wartości prognostycznej wymaga przeprowadzenia większej liczby badań rekrutujących dostatecznie duże liczebności pacjentów.

Konflikt interesów

Autorzy nie zgłaszają konfliktu interesów.

Finansowanie

Brak.

Piśmiennictwo

1. Medycyna Praktyczna [Internet]. Interna. Dodatkowe materiały. COVID-19 (choroba spowodowana przez SARS-CoV-2). 07.04.2021. https://www.mp.pl/interna/chapter/B01.XI.C.18.1 (7.06.2021).

2. Long B, Brady WJ, Bridwell RE, et al. Electrocardiographic manifestations of COVID-19. Am J Emerg Med. 2021; 41: 96–103, doi: 10.1016/j.ajem.2020.12.060, indexed in Pubmed: 33412365.
3. Madjid M, Safavi-Naeini P, Solomon SD, et al. Potential effects of coronaviruses on the cardiovascular system: a review. JAMA Cardiol. 2020; 5(7): 831–840, doi: 10.1001/jamacardio.2020.1286, indexed in Pubmed: 32219363.
4. Yenerçağ M, Arslan U, Şeker OO, et al. Evaluation of P-wave dispersion in patients with newly diagnosed coronavirus disease 2019. J Cardiovasc Med (Hagerstown). 2021; 22(3): 197–203, doi: 10.2459/JCM.0000000000001135, indexed in Pubmed: 33186236.
5. Amaratunga EA, Corwin DS, Moran L, et al. Bradycardia in patients with COVID-19: a calm before the storm? Cureus. 2020; 12(6): e8599, doi: 10.7759/cureus.8599, indexed in Pubmed: 32550090.
6. Babapoor-Farrokhran S, Batnyam U, Wiener PC, et al. Atrioventricular and sinus node dysfunction in stable COVID-19 patients. SN Compr Clin Med. 2020 [Epub ahead of print]: 1–4, doi: 10.1007/s42399-020-00497-5, indexed in Pubmed: 32901230.
7. Bertini M, Ferrari R, Guardigli G, et al. Electrocardiographic features of 431 consecutive, critically ill COVID-19 patients: an insight into the mechanisms of cardiac involvement. Europace. 2020; 22(12): 1848–1854, doi: 10.1093/europace/euaa258, indexed in Pubmed: 32944767.
8. Abrams MP, Wan EY, Waase MP, et al. Clinical and cardiac characteristics of COVID-19 mortalities in a diverse New York City Cohort. J Cardiovasc Electrophysiol. 2020; 31(12): 3086–3096, doi: 10.1111/jce.14772, indexed in Pubmed: 33022765.
9. Yildirim A, Karaca IO, Yilmaz FK, et al. Fragmented QRS on surface electrocardiography as a predictor of cardiac mortality in patients with SARS-CoV-2 infection. J Electrocardiol. 2021; 66: 108–112, doi: 10.1016/j.jelectrocard.2021.03.001, indexed in Pubmed: 33906057.
10. Li Y, Liu T, Tse G, et al. Electrocardiograhic characteristics in patients with coronavirus infection: a single-center observational study. Ann Noninvasive Electrocardiol. 2020; 25(6): e12805, doi: 10.1111/anec.12805, indexed in Pubmed: 32951285.
11. Angeli F, Spanevello A, De Ponti R, et al. Electrocardiographic features of patients with COVID-19 pneumonia. Eur J Intern Med. 2020; 78: 101–106, doi: 10.1016/j.ejim.2020.06.015, indexed in Pubmed: 32586646.
12. Wang Y, Chen L, Wang J, et al. Electrocardiogram analysis of patients with different types of COVID-19. Ann Noninvasive Electrocardiol. 2020; 25(6): e12806, doi: 10.1111/anec.12806, indexed in Pubmed: 32951316.
13. World Health Organization. COVID-19 clinical management: living guidance 25 January 2021.
14. Chen L, Feng Yi, Tang J, et al. Surface electrocardiographic characteristics in coronavirus disease 2019: repolarization abnormalities associated with cardiac involvement. ESC Heart Fail. 2020; 7(6): 4408–4415, doi: 10.1002/ehf2.12991, indexed in Pubmed: 32898341.
15. Öztürk F, Karaduman M, Çoldur R, et al. Interpretation of arrhythmogenic effects of COVID-19 disease through ECG. Aging Male. 2020; 23(5): 1362–1365, doi: 10.1080/13685538.2020.1769058, indexed in Pubmed: 32449420.
16. van den Broek MPH, Möhlmann JE, Abeln BGS, et al. Chloroquine-induced QTc prolongation in COVID-19 patients. Neth Heart J. 2020; 28(7-8): 406–409, doi: 10.1007/s12471-020-01429-7, indexed in Pubmed: 32350818.
17. Carafoli E. Chloroquine and hydroxychloroquine in the prophylaxis and therapy of COVID-19 infection. Biochem Biophys Res Commun. 2021; 538: 156–162, doi: 10.1016/j.bbrc.2020.09.128, indexed in Pubmed: 33028485.
18. Shah RR. Chloroquine and hydroxychloroquine for COVID-19: perspectives on their failure in repurposing. J Clin Pharm Ther. 2021; 46(1): 17–27, doi: 10.1111/jcpt.13267, indexed in Pubmed: 32981089.
19. Bhatla A, Mayer MM, Adusumalli S, et al. COVID-19 and cardiac arrhythmias. Heart Rhythm. 2020; 17(9): 1439–1444, doi: 10.1016/j.hrthm.2020.06.016, indexed in Pubmed: 32585191.
20. Coromilas EJ, Kochav S, Goldenthal I, et al. Worldwide survey of COVID-19-associated arrhythmias. Circ Arrhythm Electrophysiol. 2021; 14(3): e009458, doi: 10.1161/CIRCEP.120.009458, indexed in Pubmed: 33554620.
21. Gopinathannair R, Merchant FM, Lakkireddy DR, et al. COVID-19 and cardiac arrhythmias: a global perspective on arrhythmia characteristics and management strategies. J Interv Card Electrophysiol. 2020; 59(2): 329–336, doi: 10.1007/s10840-020-00789-9, indexed in Pubmed: 32494896.
22. Kho J, Ioannou A, Van den Abbeele K, et al. Pulmonary embolism in COVID-19: Clinical characteristics and cardiac implications. Am J Emerg Med. 2020; 38(10): 2142–2146, doi: 10.1016/j.ajem.2020.07.054, indexed in Pubmed: 33046316.
23. Middeldorp S, Coppens M, van Haaps TF, et al. Incidence of venous thromboembolism in hospitalized patients with COVID-19. J Thromb Haemost. 2020; 18(8): 1995–2002, doi: 10.1111/jth.14888, indexed in Pubmed: 32369666.
24. Avila J, Long B, Holladay D, et al. Thrombotic complications of COVID-19. Am J Emerg Med. 2021; 39: 213–218, doi: 10.1016/j.ajem.2020.09.065, indexed in Pubmed: 33036855.

Folia Cardiologica 2022
vol. 17, no. 1, pages 45–49
DOI: 10.5603/FC.2022.0006

ISSN 2353–7752
e-ISSN 2353–7760

Atrioesophageal fistula: clinical status and past medical history as the key to proper radiological assessment

Przetoka przedsionkowo-przełykowa — stan kliniczny oraz historia choroby jako klucz do postawienia rozpoznania w badaniu obrazowym

Weronika Pleban-Stachera, Zbigniew Grad

Imaging Diagnostics Department, Międzylesie Specialist Hospital, Warsaw, Poland

Abstract

Atrioesophageal fistula is an extremely rare, but a life-threatening complication of percutaneous ablation. With an increasing prevalence of atrial fibrillation and an increasing number of percutaneous ablation procedures following it, awareness of catheter ablation complications and their detection should be raised.

A 69-year-old male, with a history of atrial fibrillation was admitted with a suspicion of a stroke. The patient was treated with percutaneous ablation 27 days earlier in a different hospital. On admission, in addition to the neurological symptoms, moderately increased inflammatory markers and a low-grade fever were found. During the hospitalisation, a prompt inflammatory markers elevation was observed and the patient's condition had gradually worsened. Sepsis was diagnosed and a broad-spectrum antibiotic therapy was administered. On the 6th day of hospitalisation the patient went into cardiac arrest. Cardiopulmonary resuscitation was successful and return of spontaneous circulation occurred. An electrocardiogram showed changes typical for ST elevation myocardial infarction. An emergent coronary angiogram showed no significant stenosis in any of the coronary arteries. In a follow-up, brain non-enhanced brain computed tomography (NECT) air emboli were detected. A chest NECT was performed and revealed free gas within the left atrium and in the pericardial cavity, which in juxtaposition with the patient's medical history suggested presence of an atrioesophageal fistula. Despite all taken measures, the patient died. An autopsy confirmed atrioesophageal fistula connecting oesophagus with left atrium.

The purpose of this case is to raise awareness of percutaneous ablation complications among both clinicians and radiologists. It emphasizes how crucial precise clinical data and imaging exams are in diagnosing atrioesophageal fistula.

Key words: atrioesophageal fistula, percutaneous ablation, cerebral air embolism, atrial fibrillation, stroke

Folia Cardiologica 2022; 17, 1: 45–49

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia. Its prevalence is increasing [1], therefore the number of catheter ablation (CA) procedures is rising. This entails a greater chance of encountering CA complications in daily practice. The overall complication rate for CA is estimated up to 14% [2].

Atrioesophageal fistula (AEF) is an extremely rare, but life-threatening complication of CA. In most reported cases

Address for correspondence: Weronika Pleban-Stachera MD, Zakład Diagnostyki Obrazowej, Międzyleski Szpital Specjalistyczny, Bursztynowa 2, 04–479 Warszawa, Poland, e-mail: weronikapleban@gmail.com

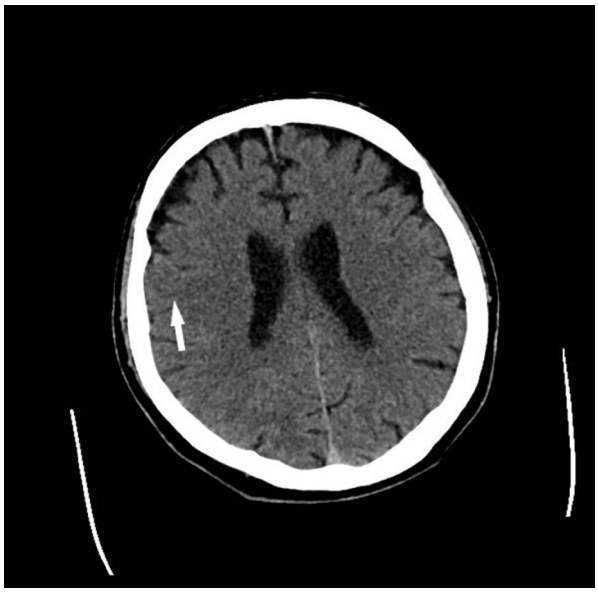


Figure 1. Initial brain computed tomography (CT) showed subtle loss of grey-white matter differentiation in the right frontal lobe (arrow)

symptoms of AEF's presence occur with a delay after CA and present as an unspecific combination of clinical features, making AEF a diagnostic challenge.

Case report

A 69-year-old male, with a history of AF, treated with rivaroxaban and multiple CA procedures, was admitted with left-sided hemiparesis and mixed non-fluent aphasia. The patient underwent the last CA by pulmonary vein isolation procedure 27 days prior in a different hospital.

On admission the following were found: low-grade fever of 37.4°C, elevated inflammatory markers — white blood cell 10.2 G/L (n = 4.0–10.0), C-reactive protein (CRP) 20.7 mg/L (n < 5.0). Chest X-ray showed no significant abnormalities.

Non-enhanced brain computed tomography (NECT) demonstrated subtle loss of grey-white matter differentiation in the right frontal lobe — a suspicion of an early ischemic stroke was raised (Figure 1).

Several hours after the admission the patient's condition worsened and rapid elevation of inflammatory markers was observed — white blood cell to 24.6 G/L, CRP 48.5 mg/L. Empirical antibiotic therapy was administered. Polymerase chain reaction tests ruled out influenza, coronavirus disease 2019 (COVID-19), and respiratory syncytial virus infections.

In the blood culture test *Streptococcus mitis*, an oral colonizer was detected and infective endocarditis was suspected. A transthoracic echocardiogram did not reveal any vegetations on valves.

Despite the broad-spectrum antibiotic therapy, further increase of inflammatory markers was observed, CRP value 144.6 mg/L, procalcitonin level 47.705 ng/mL indicating a high chance of severe sepsis.

Chest computed tomography (CT) showed pulmonary consolidations, bilateral pleural effusion, cardiomegaly, and pulmonary interstitial oedema. No embolic occlusion of the pulmonary arteries was detected (Figure 2).

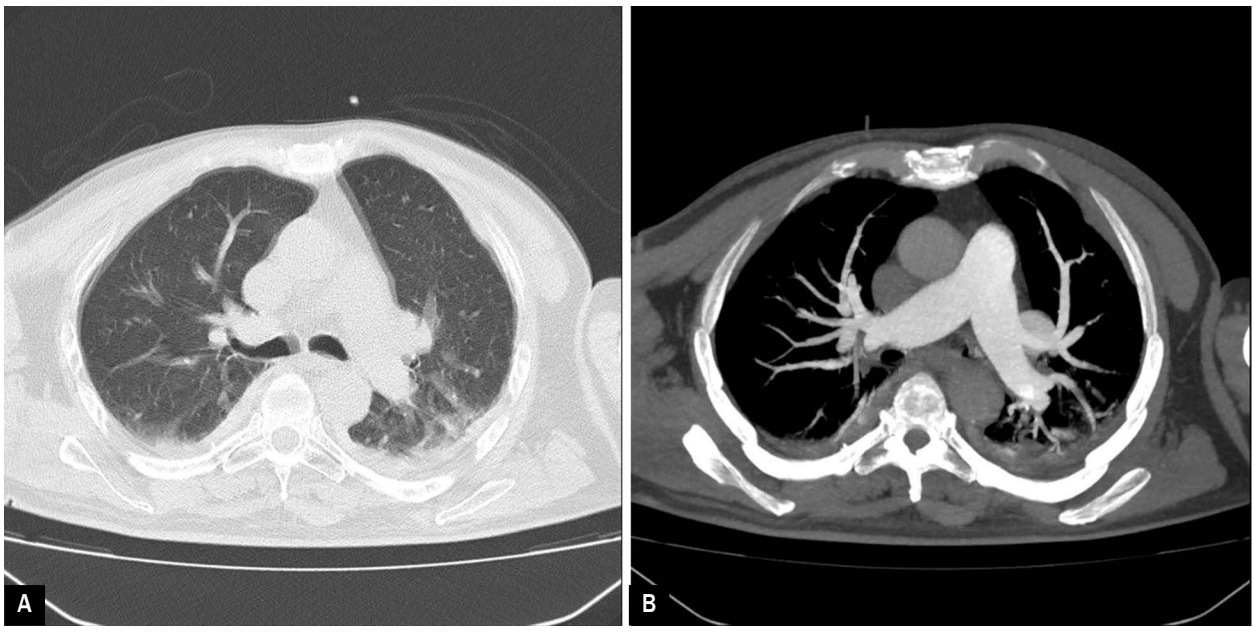


Figure 2A. Chest computed tomography (CT) with motion artifacts showed bilateral pleural effusion and pulmonary consolidations; **B.** CT pulmonary angiography in maximum intensity projection (MIP) excluded embolic occlusion of the pulmonary arteries

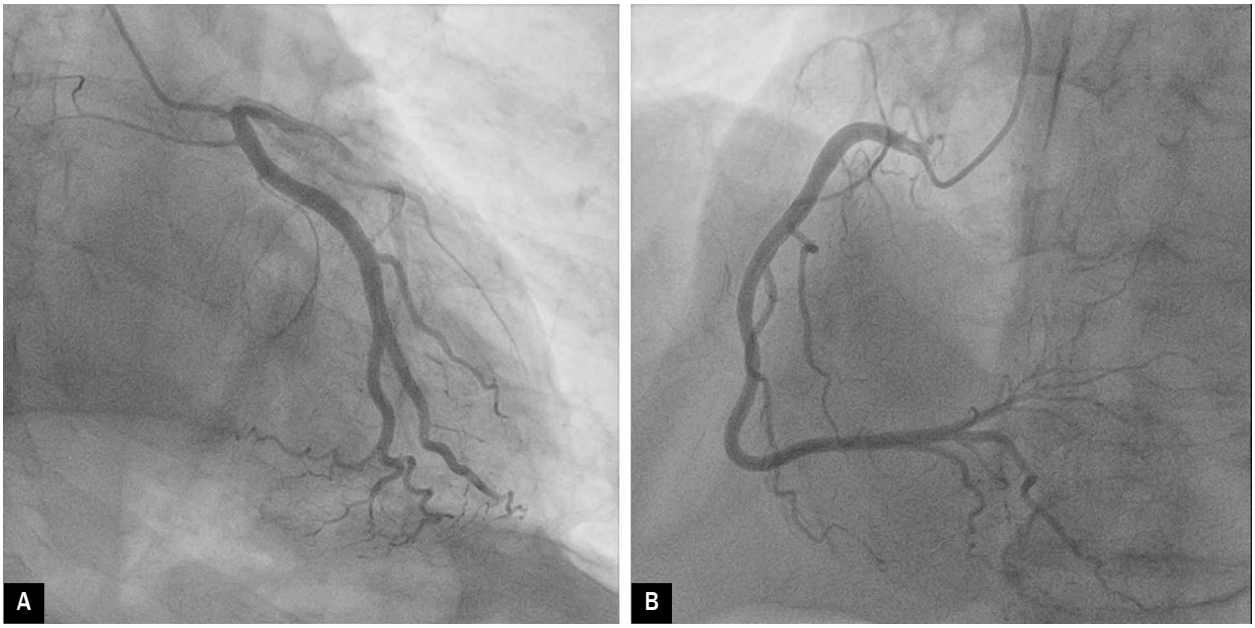


Figure 3A, B. Coronary angiography. No abnormalities on the left and right coronary artery angiography

The patient remained in a severe condition, on the 6th day went into cardiac arrest. Cardiopulmonary resuscitation was successful. An electrocardiogram showed changes typical for ST-elevation myocardial infarction. An emergent coronary angiogram showed no significant stenosis in any of the coronary arteries (Figure 3).

A follow-up brain NECT revealed hyperdense focal areas containing air densities, consistent with either intracranial haemorrhages or contrast extravasation after the coronarography. More areas were matching acute infarcts with mild right hemisphere oedema and hyperdense material involving its sulci that could correspond with subarachnoid haemorrhage or contrast staining after the angiography. These findings could have been caused by the introduction of air during the coronarography or a cardiopulmonary resuscitation (CPR) injury, therefore requiring chest imaging. Chest NECT showed no signs of injuries, but revealed gas within the left atrium and in pericardial cavity (Figure 4).

Based on the patient's medical history, air presence in the pericardium and left atrium AEF was suspected.

The patient remained in severe condition. Despite all taken measures, the patient died. An autopsy confirmed AEF connecting oesophagus with left atrium.

Discussion

Identification of air bubble in an imaging exam requires a close correlation between acquired images and clinical data. In the presented case air embolism differential diagnosis began with detecting air in a brain NECT. Given the history of CPR and coronarography preceding the brain CT, a likely cause of cerebral air embolism was either a CPR injury where positive pressure manoeuvres ruptured small pulmonary arteries or an introduction of air during cardiac catheterisation [3, 4]. Since air emboli occurred within less than a month of CA procedure AEF should also be included in the differential diagnosis. Even though AEFs are an extremely rare complication of CA, with a frequency rate of less than 0.1% [5], they are reported to be the second most frequent cause of death associated with CA of AF. Mortality rate is between 55% and 71% [6, 7].

Typical, but unspecific symptoms of AEF include neurological, cardiac, gastroenterological disorders and signs of infection. The most common symptoms are neurological ones and fever, occurring with respectively 72% and 73% rates [6]. AEF signs usually occur after a patient is discharged from a hospital, thus it is easily overlooked. In most cases, including this one, symptoms of AEF occur at 2–4 weeks after the procedure [5].

Chest CT is suggested to be the method of choice in diagnosing AEF. It can present air within heart chambers, pericardium, or mediastinum, as well as abnormalities in the left atrium such as thrombi or esophageal changes. If the initial chest CT is insufficient a repeat chest CT is suggested. In the presented case only the second thoracic CT revealed free air.

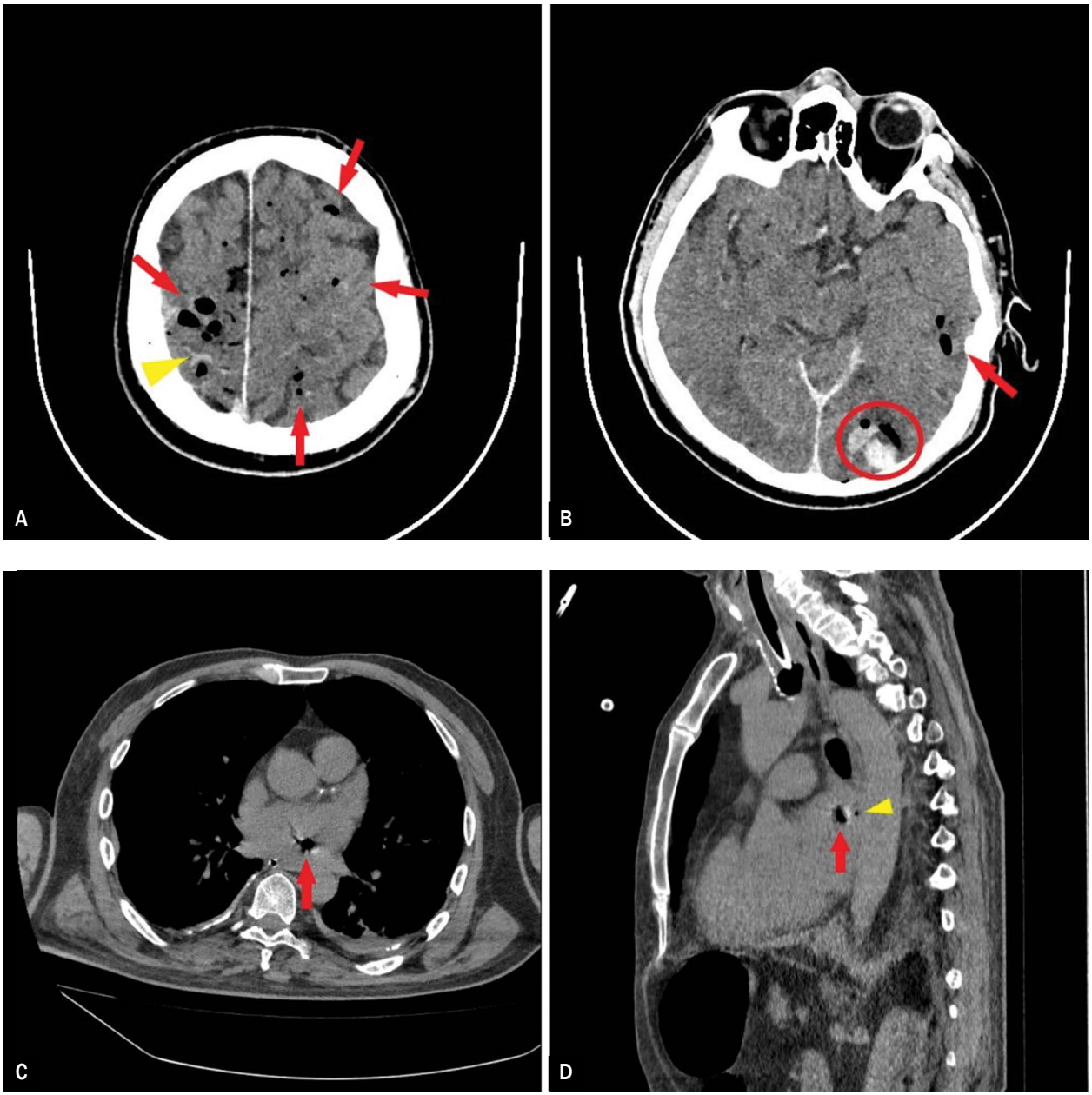


Figure 4.A, B. A follow-up non-contrast brain computed tomography (CT) performed right after the coronarography: multiple cerebral and cerebellar air emboli (red arrows), hyperdense material in sulci of the right parietal lobe (arrowhead), focal hyperdense areas containing small air densities (circles); **C, D.** Non-contrast chest CT showed gas densities in the left atrium (red arrow) and pericardial cavity (yellow arrowhead) suggesting atrioesophageal fistula atrioesophageal fistula (AEF) presence

Conclusions

The purpose of this case is to raise awareness of percutaneous ablation complications among both clinicians and radiologists. It emphasizes how crucial precise clinical data and imaging exams are in diagnosing AEF.

Conflict of interest

The authors declare no conflicts of interest.

Funding

None.

Streszczenie

Przetoka przedsionkowo-przełykowa jest wyjątkowo rzadkim, ale stanowiącym zagrożenie życia powikłaniem po zabiegu ablacji przezskórnej. W związku z rosnącą częstością występowania migotania przedsionków, a co za tym idzie zwiększającą się liczbą wykonywanych zabiegów ablacji przezskórnej, powinna również wzrastać świadomość występujących powikłań po tym zabiegu oraz metod ich rozpoznawania.

Pacjent w wieku 69 lat z migotaniem przedsionków w wywiadzie został przyjęty do szpitala z powodu podejrzenia udaru mózgu. Pacjent 27 dni wcześniej przebył zabieg ablacji przezskórnej. Przy przyjęciu stwierdzono również umiarkowanie podwyższone laboratoryjne wskaźniki stanu zapalnego oraz stan podgorączkowy. W trakcie hospitalizacji zaobserwowano gwałtowne narastanie wykładników stanu zapalnego oraz stopniowe pogarszanie się ogólnego stanu chorego. Rozpoznano sepsę i włączono szerokospektralną antybiotykoterapię. Szóstego dnia hospitalizacji doszło do zatrzymania krążenia. Rozpoczęto resuscytację krążeniowo-oddechową, która przywróciła spontaniczne krążenie. W wykonanym badaniu elektrokardiograficznym zaobserwowano cechy zawału serca z uniesieniem odcinka ST. Pilna koronarografia nie wykazała jednak zmian w naczyniach wieńcowych. Wykonano kontrolne badanie tomografii komputerowej (CT) głowy bez podania środka kontrastowego, które wykazało obecność zatorów powietrznych. Badanie CT klatki piersiowej bez podania środka kontrastowego ujawniło obecność wolnego gazu w lewym przedsionku oraz osierdziu, co w zestawieniu z wywiadem chorobowym pacjenta wskazało na możliwą obecność przetoki przedsionkowo-przełykowej. Mimo wszystkich starań pacjent zmarł. W badaniu autopsyjnym potwierdzono obecność przetoki przedsionkowo-przełykowej między lewym przedsionkiem a przełykiem.

Celem przedstawienia tego opisu przypadku było pogłębieine wiedzy o powikłaniach po zabiegu przezskórnej ablacji, zarówno wśród klinicystów, jak i radiologów. Wskazuje on, jak ważna jest rola danych klinicznych oraz badań obrazowych w rozpoznaniu przetoki przedsionkowo-przełykowej.

Słowa kluczowe: przetoka przedsionkowo-przełykowa, ablacja przezskórna, mózgowy zator powietrzny, migotanie przedsionków, udar mózgu

Folia Cardiologica 2022; 17, 1: 45–49

References

1. Hindricks G, Potpara T, Dagres N, et al. ESC Scientific Document Group. 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): The Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC. Eur Heart J. 2021; 42(5): 373–498, doi: 10.1093/eurheartj/ehaa612, indexed in Pubmed: 32860505.
2. Steinbeck G, Sinner MF, Lutz M, et al. Incidence of complications related to catheter ablation of atrial fibrillation and atrial flutter: a nationwide in-hospital analysis of administrative data for Germany in 2014. Eur Heart J. 2018; 39(45): 4020–4029, doi: 10.1093/eurheartj/ehy452, indexed in Pubmed: 30085086.
3. Arena V, Capelli A. Venous air embolism after cardiopulmonary resuscitation: the first case with histological confirmation. Cardiovasc Pathol. 2010; 19(2): e43–e44, doi: 10.1016/j.carpath.2008.10.002, indexed in Pubmed: 19144542.
4. Leclercq F, Kassnasrallah S, Cesari JB, et al. Transcranial doppler detection of cerebral microemboli during left heart catheterization. Cerebrovasc Dis. 2001; 12(1): 59–65, doi: 10.1159/000047682, indexed in Pubmed: 11435681.
5. Gupta A, Perera T, Ganesan A, et al. Complications of catheter ablation of atrial fibrillation: a systematic review. Circ Arrhythm Electrophysiol. 2013; 6(6): 1082–1088, doi: 10.1161/CIRCEP.113.000768, indexed in Pubmed: 24243785.
6. Han HC, Ha FJ, Sanders P, et al. Atrioesophageal fistula: clinical presentation, procedural characteristics, diagnostic investigations, and treatment outcomes. Circ Arrhythm Electrophysiol. 2017; 10(11): e005579, doi: 10.1161/CIRCEP.117.005579, indexed in Pubmed: 29109075.
7. Cappato R, Calkins H, Chen SA, et al. Prevalence and causes of fatal outcome in catheter ablation of atrial fibrillation. J Am Coll Cardiol. 2009; 53(19): 1798–1803, doi: 10.1016/j.jacc.2009.02.022, indexed in Pubmed: 19422987.

Folia Cardiologica 2022
vol. 17, no. 1, pages 50–53
DOI: 10.5603/FC.2022.0007

ISSN 2353–7752
e-ISSN 2353–7760

Left lung hypoplasia and arrhythmia: a rare case

Hipoplazja lewego płuca i niemiarowość — rzadki przypadek

Muammer Karakayalı, Timor Omar

Kars Harakani State Hospital, Department of Cardiology, Kars, Turkey

Abstract

Pulmonary hypoplasia is a rare congenital disorder. Respiratory and circulatory systems sustain a closely correlated function, and if the function of one is impaired, the other will inescapably be affected. We presented a unilateral lung hypoplasia case that manifested a cardiological disorder (ventricular arrhythmia) rather than a respiratory-related symptom. We highly recommend that such patients should be followed-up by a cardiologist beside a pulmonologist.

Key words: lung hypoplasia, arrhythmia, echocardiography, congenital lung disorder

Folia Cardiologica 2022; 17, 1: 50–53

Introduction

Pulmonary hypoplasia, which is the result of insult to the embryo during the 4th to 5th week of intrauterine life, is a rare congenital disorder. Incidence of this entity ranges from 1–2/10,000 live births [1]. Both genders are affected almost equally. Usually, it is unilateral and is characterized by a decrease in the number or size of the airways, vessels, and alveoli resulting in a small fibrotic and nonfunctioning lung. Also, pulmonary artery and vein atresia could accompany, sometimes [2]. Computed tomography (CT) is a favourable tool for diagnosis [3].

Respiratory and circulatory systems sustain a closely correlated function. If one develops a pathology, the other will inevitably be affected. Here we describe a unilateral lung hypoplasia case that showed ventricular arrhythmia.

Case presentation

A 49-year-old female patient, who had no known history of chronic disease, presented to the cardiology outpatient clinic with an occasional palpitation. Her initial vital findings were as follows; blood pressure, 122/76 mm Hg; heart rate, 85/minute; body temperature, 36.5°C; saturation, 98%. On physical examination, left-sided lung did not attend to inspirium, auscultation sounds of his left lung could not have been detected, and obvious left-sided dullness was located on percussion. 12-lead electrocardiogram (ECG) showed sinus rhythm and two ventricular extra beats with a rate of 85 beats/minute (Figure 1). According to laboratory parameters, biochemistry, haematology and thyroid function tests were within the normal range but total cholesterol was 250 mg/dL (reference range < 200 mg/dL). Transthoracic echocardiography (TTE) revealed dilatation in right heart chambers (right ventricle; 4.6 cm, right atrium; 4.5 cm), a thin and aneurysmatic interatrial septum, elevated pulmonary arterial systolic pressure (40 mm Hg), and that the anatomical position of the heart was shifted to the left (Figure 2A, B, C). A contrast-enhanced thorax CT angiography was performed to reveal detailed anatomy and clarify the diagnosis. The CT demonstrated

Address to correspondence: Dr. Timor Omar, Kars Harakani State Hospital, Department of Cardiology, Kars, Turkey, phone +90 53 19 109 530, e-mail: tbigmurad@gmail.com

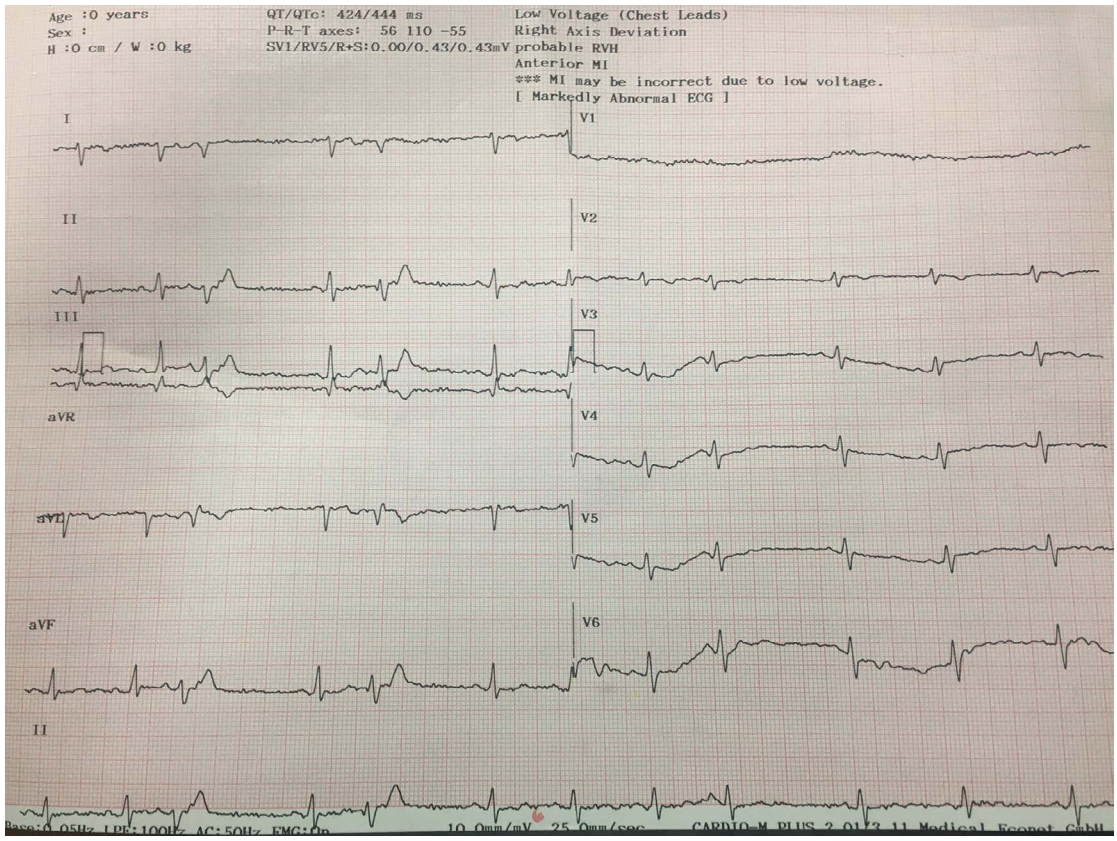


Figure 1. Electrocardiogram: Sinus rhythm, a rate of 85 beats/min and ventricular extra beats

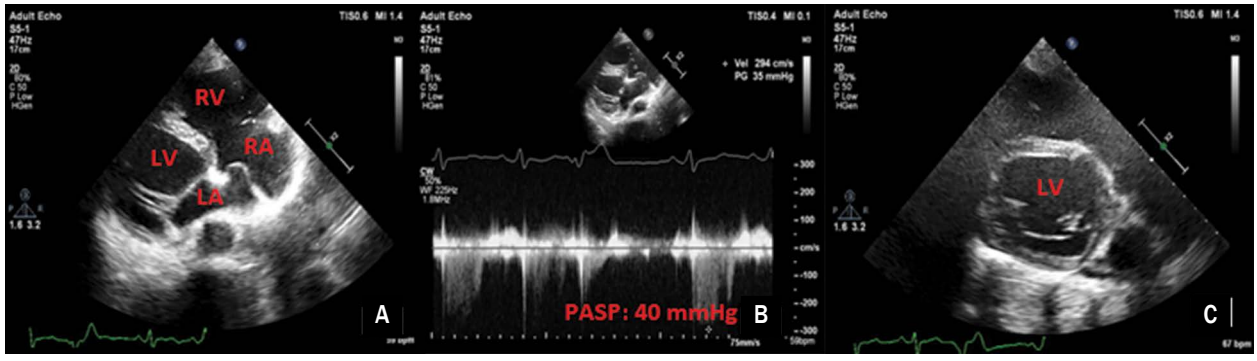


Figure 2. Transthoracic echocardiography; parasternal long axis: **A.** Right heart chambers were dilated. The interatrial septum was thin and aneurysmatic; **B.** Pulmonary arterial systolic pressure (PASP): 40 mm Hg; **C.** The left pulmonary vein and arteries could not have been seen; LA — left atrium; LV — left ventricle; RA — right atrium; RV — right ventricle

a hypoplastic left lung and a shifted mediastinum to the left side. Additionally, hypertrophy and emphysema were observed in the right lung, and the right lung upper lobe extended to the left lung side (Figure 3A, B, C). A 24-hour ambulatory rhythm Holter showed a total of 15,000 extra ventricular beats. A 50 mg metoprolol pill once a day was started and the patient was referred to the chest disease clinic for follow-up.

Discussion

Lung malformations, which are the results of insult to the embryo during the 4th to 5th week of intrauterine life, are very rare to occur with varying degrees of severity and with an incidence as low as 1–2/10,000–12,000 births [2, 3]. Boyden categorized them as pulmonary agenesis, aplasia, and hypoplasia[4]. Hypoplasia, which

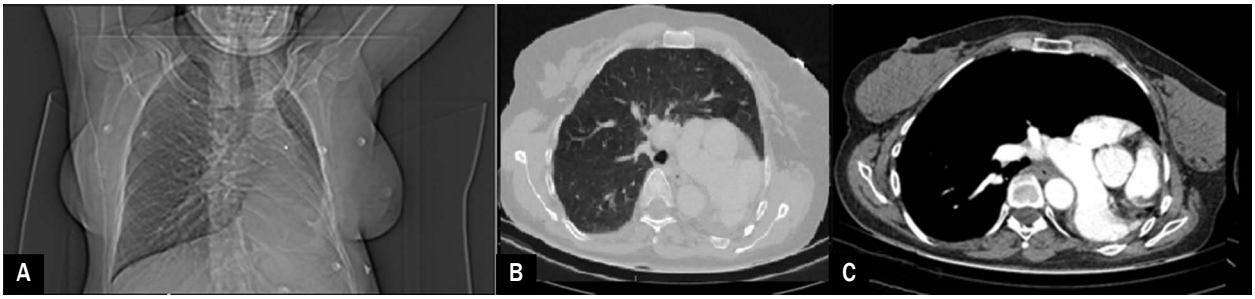


Figure 3. Contrast-enhanced thorax computed tomography: **A.** The patient's left lung was hypoplasic, mediastinum shifted to the left; **B.** Hypertrophy findings and areas of emphysema were observed in the right lung; **C.** Upper lobe of right lung extended and located to the upper part of the left-sided lung space

is the subject of the current article, generally appear to be unilateral [5]. Our case showed left-sided lung hypoplasia.

Although the certain cause is not entirely understood, deficiency of some elements, such as thyroid transcription factor-1, hepatocyte nuclear factors, epidermal growth factor, and its mitogen-activated protein kinase receptor, are presumed hypotheses. Besides that small fetal thoracic volume, prolonged oligohydramnios, early rupture of membranes, congenital heart diseases, and trisomies 13, 18, and 21 may play role in the development of this entity [6, 7].

Considering the literature, a small number of left lung hypoplasia cases have been reported, so far. Here, we present a left lung hypoplasia patient who developed cardiac arrhythmia. It is the first case in the literature that presented to the cardiology clinic with an occasional palpitation rather than pulmonary insufficiency symptoms and that diagnosed incidentally by a cardiologist.

Usually, pulmonary hypoplasia cases presented with recurrent chest infections or symptoms of cardiopulmonary insufficiency [4]. In our case, dissimilarly, there was no respiratory complaint. ECG showed two and 24-hour ambulatory rhythm Holter showed a significant number of ventricular extra beats. In this case, it is a question point whether the ventricular extra beats were a result of lung hypoplasia or completely coincidental. Even though it is hard to link arrhythmia to lung malformation, we presume it was due to elevated pulmonary artery systolic pressure and right ventricular enlargement which was a result of left lung hypoplasia. After all, it should de be kept in mind that such patients could have a cardiological complaint and disorder. These patients should be followed up by a cardiologist besides a pulmonologist to prevent future possible cardiological complications.

To associate arrhythmia with lung malformations further studies and similar case examples are needed in this field.

Limitation

Due to the transposition of the heart, it was hard to reveal appropriate echocardiographical views, especially the apical four-champer view.

Conclusion

Lung hypoplasia cases could manifest with a cardiological sign. Respiratory and circulatory systems sustain a closely correlated function, and if the function of one is impaired, the other will inescapably be affected. Therefore, such patients should be followed-up by a cardiologist beside a pulmonologist.

Acknowledgements

None.

Contributions

Elevation of the patient in the cardiology clinic, MK; preparation of the manuscript, TO.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Streszczenie

Hipoplazja płuca jest wadą wrodzoną. Układy oddechowy i krwionośny pełnią ściśle skorelowane funkcje; jeżeli funkcjonowanie jednego z tych układów jest zaburzone, to ma to wpływ na drugi układ. W pracy przedstawiono przypadek jednostronnej hipoplazji płuca, która przejawia się zaburzeniami kardiologicznymi (arytmia komorowa), a nie objawami związanymi z układem oddechowym. Zalecamy, aby tacy pacjenci byli monitorowani zarówno przez kardiologa, jak i pulmonologa.

Słowa kluczowe: hipoplazja płuca, niemiarowość, echokardiografia, wrodzona wada płuc

Folia Cardiologica 2022; 17, 1: 50–53

References

1. Zhang L, Ai T, Wang Li, et al. Hypoplasia of the left lung presenting as hemoptysis: a case report. Medicine (Baltimore). 2019; 98(4): e14077, doi: 10.1097/MD.0000000000014077, indexed in Pubmed: 30681564.
2. Collin P. Development of the thorax. In: Standring S. ed. Gray's anatomy. Elsevier Publisher, Philadelphia, PA 2008: 1013–1036.
3. Cherian D, Shalini C, Andrews C, et al. Evaluation of pulmonary hypoplasia in various congenital anomalies with a comparison of two conventional methods of assessment: radial alveolar count (rac) and lung weight: body weight ratio (lbw). Turk Patoloji Derg. 2021; 37(2): 154–160, doi: 10.5146/tjpath.2021.01521, indexed in Pubmed: 33432563.
4. Bouden EA. Developmental anomalies of the lungs. Am J Surg. 1955; 89(1): 79–89, doi: 10.1016/0002-9610(55)90510-9, indexed in Pubmed: 13218221.
5. Pinheiro G, Alves AM, Rodrigues Neves I, et al. Left lung and pulmonary artery hypoplasia: a rare case of hemoptysis. Eur J Case Rep Intern Med. 2020; 7(7): 001490, doi: 10.12890/2020_001490, indexed in Pubmed: 32665919.
6. Warburton D, Olver BE. Coordination of genetic, epigenetic, and environmental factors in lung development, injury, and repair. Chest. 1997; 111(6 Suppl): 119S–122S, doi: 10.1378/chest.111.6_supplement.119s, indexed in Pubmed: 9184557.
7. Tisekar O. Hypoplastic lung disease article. https://www.statpearls.com/ArticleLibrary/viewarticle/23287. https://www.statpearls.com/ArticleLibrary/viewarticle/23287 (December 31, 2021).

Folia Cardiologica 2022
vol. 17, no. 1, pages 54–57
DOI: 10.5603/FC.a2022.0002

ISSN 2353–7752
e-ISSN 2353–7760

Lung ultrasound as a part of cardiological assessment of physically active person after COVID-19

Maria Binkiewicz-Orluk[1], Marcin Konopka[1], Agnieszka Jakubiak[2], Wojciech Król[1], Marek Kuch[2], Wojciech Braksator[1]

[1]Department of Sports Cardiology and Noninvasive Cardiovascular Imaging, Medical University of Warsaw, Warsaw, Poland
[2]Department of Cardiology, Hypertension and Internal Diseases, Medical University of Warsaw, Poland

Abstract

Both the ongoing severe acute respiratory syndrome-related coronavirus 2 pandemic and increasing number of survivors after coronavirus disease 2019 (COVID-19) state new challenges. One of them is proper assessment after infection in order to safe return to professional, physical and social activity and avoidance of undiagnosed, potentially life-threating complications. Significant element is a choice of diagnostic methods for evaluation of the parenchymal changes within the lungs. Despite high resolution computed tomography is still a gold standard, the use of lung ultrasonography is still increasing. It is a complementary diagnostic method which might be performed simultaneously with echocardiography. We present the proposition of use lung ultrasound in a 34-year-old patient, elite athletes- trainer after COVID-19, who developed parenchymal lung changes and recovered from them in a short time interval.

Key words: lung ultrasonography, COVID-19, post-COVID complications, sports medicine

Folia Cardiologica 2022; 17, 1: 54–57

Case report

A 34-year-old physically active male coach of competitive athletes was admitted to the hospital for evaluation after coronavirus disease 2019 (COVID-19) disease.

Medical history of the patient in question during COVID-19 infection: muscle and joint pain, weakness, fever, cough (> 14 days), dyspnoea, reduced saturation to 90%, chest tightness. The patient was treated on an outpatient basis and took antipyretics.

He was assessed on day 23 after a positive polymerase chain reaction (PCR) test — good overall clinical condition, without dyspnoea or stenocardia. Vital signs were normal, electrocardiogram (ECG) revealed sinus bradycardia with a heart rate of 52/min, ECG recording was normal for a physically active person. Laboratory tests revealed leukopenia — 3.75 thousand/µl (neutrophil count in blood smear: 1.51 thousand/µl), increased activity of both alanine transaminase (ALT) — 199 U/l and aspartate transaminase (AST) — 60 U/l, elevated ferritin levels — 361.1 ng/mL; elevated levels of N-terminal pro-B-type natriuretic peptide (NT-proBNP), D-dimers and high-sensitivity cardiac troponin; the results of C-reactive protein (CRP) and other tests were normal. The patient's serum had anti- severe acute respiratory syndrome-related coronavirus 2 (anti-SARS CoV-2) antibodies, IgM 29.68 S/C (positive values for ≥ 1.4 S/C), and IgG 8.20 S/C (positive values for ≥ 1 S/C). The echocardiogram revealed normal geometry and proportion of cardiac chambers, normal systolic and diastolic function of both ventricles, normal valvular apparatus, a trace of pericardial fluid. In the 24-hour Holter monitoring, the mean heart rate

Adress for correspondence: Maria Binkiewicz-Orluk MD, Klinika Kardiologii, Nadciśnienia Tętniczego i Chorób Wewnętrznych, ul. Kondratowicza 8, 03–242 Warszawa, Poland, phone +48 22 326 55 05, e-mail: maria.binkiewicz@gmail.com

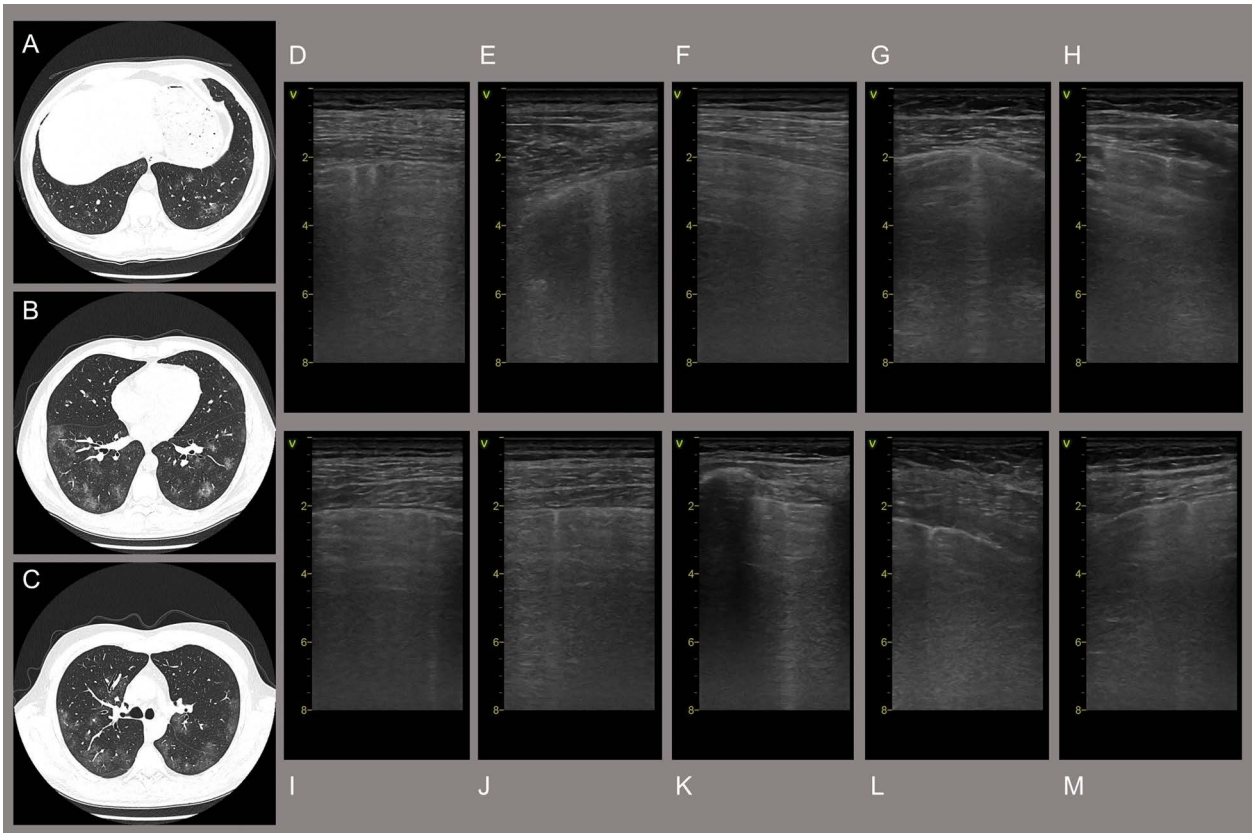


Figure 1. The chest imaging performed on day 23 after a positive polymerase chain reaction (PCR) test result, using different modalities: **A–C.** The high-resolution computed tomography (HRCT) of the chest revealed bilateral diffuse areas of ground glass opacities, occupying approximately 30% of the lung parenchyma; **D–M.** Lung ultrasound (LUS) found 1) changes in pleural line: irregularities (**E, H, I, L, M**) and interruption of continuity (**L, M**), 2) small subpleural consolidations accompanied by C lines (**E, G, I–K**), 3) A-line artifacts (**F**)

was 66/min, minimum 44/min, maximum 120/min. No arrhythmia was recorded.

Lung ultrasound (LUS) revealed several abnormalities in most areas of the lungs. These abnormalities included 1) pleural line irregularity and interruption of continuity, 2) multiple, small, subpleural inflammatory consolidations accompanied by C lines (Figure 1).

The high-resolution computed tomography (HRCT) revealed areas of ground glass opacities, occupying approx. 30% of the lung parenchyma. Moreover, there was a 3 mm nodule in the right lung apex and small adhesions in both lung apices above the diaphragm. In addition, the presence of pericardial fluid (up to 10 mm) was proved, which corresponded to the echocardiographic picture.

Because of abnormalities found in laboratory tests and imaging tests, a well-balanced lifestyle, breathing exercises, and self-monitoring were recommended.

The patient was reevaluated after less than 11 weeks. Laboratory tests revealed mild leukopenia (3.88 thousand/ /μL) with normal smear; significant reduction in the activity of aminotransferases (ALT 67 U/L, AST 24 U/L); normalisation of ferritin levels, without abnormalities in other tests. Positive IgM (4.72 S/C) and IgG (7.32 S/C) antibody titers were preserved. Echocardiography (echocardiogram) did not reveal the previously present pericardial fluid.

LUS revealed significant regression of previously found lesions — the predominance of A-line artifacts indicating normal lung aeration, which corresponded to the follow-up HRCT — areas of ground glass opacities were found only in a small area of the right lung lower lobe (Figure 2).

To complete the evaluation, an exercise test was performed according to the Bruce protocol — the test was completed when the maximum heart rate was reached at a load of 16.5 metabolic equivalents (METs) and fatigue was 9/10 points on the modified Borg scale, which proved very good exercise tolerance.

The patient returned to full work capacity and physical activity.

Discussion

Another challenge posed by the SARS-CoV-2 pandemic is to make recovery, i.e. return to work capacity and physical activity, safe.

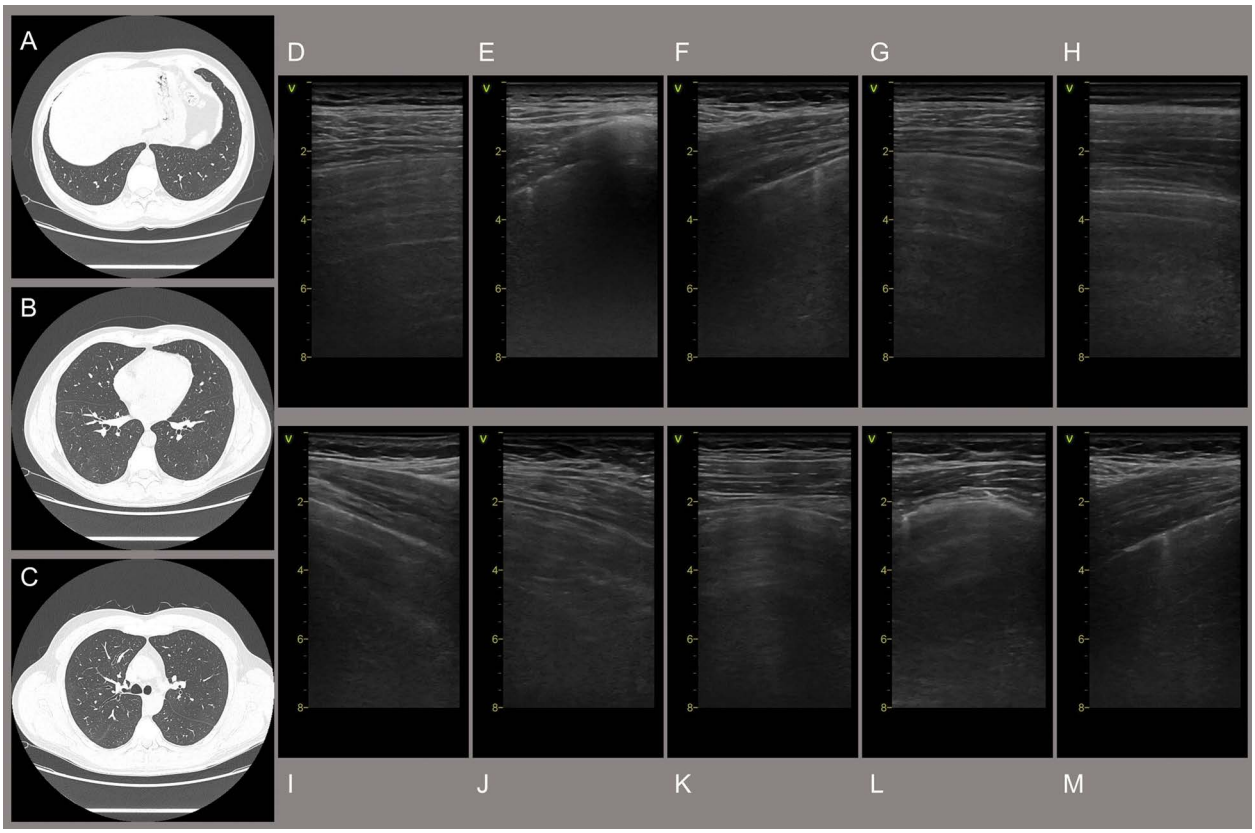


Figure 2. The chest imaging performed on day 99 after a positive polymerase chain reaction (PCR) test result, using different modalities: **A–C.** The high-resolution computed tomography (HRCT) of the chest revealed significant regression of lesions compared to the previous examinations: lung parenchyma without significant consolidations; **D–M.** Lung ultrasound (LUS) revealed significant regression of lesions. The following abnormalities were found: 1) A-line artifacts (**D, G, H, I–K**), 2) irregularity of the pleural line (**E, F, L, M**) and its small defects (**E, F**), 3) small subpleural consolidations accompanied by C lines (**F, L, M**)

In athletes, the assessment of the cardiovascular system is particularly crucial for early diagnosis of life-threatening complications (pulmonary embolism, acute coronary syndromes, arrhythmias, myocarditis, pericarditis or heart failure) [1]. Cardiological assessment methods can be found in the literature in the form of return to play protocols [2]. Although they differ slightly, each method recommends a cardiological assessment in symptomatic patients before their return to intensive training; procedures depend on the duration and severity of symptoms. American guidelines recommend laboratory tests including troponin testing, electrocardiogram, and echocardiogram; depending on obtained results, other tests such as cardiac magnetic resonance (CMR) should be considered. In other protocols, there are suggestions for performing 24-hour Holter monitoring and exercise tests, including spiroergometry. In view of the fact that there are no standardised guidelines, individual decisions are of great importance.

In the reported case, several cardiological examinations (laboratory tests, echocardiography, Holter monitoring, exercise tests) were performed, in which no significant abnormalities were found.

Concerns about the development of pulmonary fibrosis as a residual form of interstitial lesions are reflected in the experience of previous epidemics caused by coronaviruses such as severe acute respiratory syndrome (SARS) and Midle East respiratory syndrome (MERS) [3]. There are data that HRCT lesions that are typical of COVID-19 disease (ground glass opacities, cobblestone pattern, inflammatory consolidations, streaky subpleural lesions) persist in up to 77% of individuals at 2 months and in 63% at 3 months after the infection [4].

The accessibility of COVID-19-specific lesions for ultrasound, lack of exposure to ionizing radiation, relatively high sensitivity, reproducibility, the possibility of performing point-of-care examinations, and rapid learning curve have contributed to a significantly increased interest in LUS [5]. From a cardiological point of view, an additional advantage is the possibility of a rapid screening assessment of the lung parenchyma during echocardiography. This method for the assessment of active COVID-19 in hospitalised patients

has been well established in the literature [6]. There are promising results regarding the use of LUS in the assessment of lesion evolution for the diagnosis of interstitial lung disease (ILD) and other complications – according to some authors, LUS should be the first-line test [5].

Typical ultrasound changes in COVID-19 disease include irregular and/or interrupted pleural line, B-line artifacts, and inflammatory consolidations (smaller, subpleural consolidations accompanied by C lines, or larger, lobular consolidations). During the recovery phase, there is a gradual regression of the above-mentioned abnormalities, as demonstrated by an increase in the number of areas with A-line artifacts that reflect a properly aerated lung parenchyma [5], which was proved in the reported case.

Conclusions

The assessment of patients after COVID-19 is reasonable because of the risk of complications involving various organs and systems. Cardiac screening can be performed using available return to play protocols. Both HRCT and LUS are appropriate methods to assess the evolution of interstitial lesions after COVID-19.

Conflict of interest

The authors declare no conflicts of interest.

Funding

None.

References

1. Madjid M, Safavi-Naeini P, Solomon SD, et al. Potential effects of coronaviruses on the cardiovascular system: a review. JAMA Cardiol. 2020; 5(7): 831–840, doi: 10.1001/jamacardio.2020.1286, indexed in Pubmed: 32219363.
2. Phelan D, Kim JH, Chung EH. A game plan for the resumption of sport and exercise after coronavirus disease 2019 (COVID-19) infection. JAMA Cardiol. 2020; 5(10): 1085–1086, doi: 10.1001/jamacardio.2020.2136, indexed in Pubmed: 32402054.
3. Chan KS, Zheng JP, Mok YW, et al. SARS: prognosis, outcome and sequelae. Respirology. 2003; 8(Suppl): S36–S40, doi: 10.1046/j.1440-1843.2003.00522.x, indexed in Pubmed: 15018132.
4. Sonnweber T, Sahanic S, Pizzini A, et al. Cardiopulmonary recovery after COVID-19: an observational prospective multicentre trial. Eur Respir J. 2020; 57(4): 2003481, doi: 10.1183/13993003.03481-2020.
5. Peixoto AO, Costa RM, Uzun R, et al. Applicability of lung ultrasound in COVID-19 diagnosis and evaluation of the disease progression: a systematic review. Pulmonology. 2021; 27(6): 529–562, doi: 10.1016/j.pulmoe.2021.02.004, indexed in Pubmed: 33931378.
6. Treanor L, Islam N, Ebrahimzadeh S, et al. The cochrane systematic review on thoracic imaging tests for the diagnosis of COVID-19. Radiology. 2021; 299(3): E289, doi: 10.1148/radiol.2021210564, indexed in Pubmed: 33754831.

Folia Cardiologica 2022
tom 17, nr 1, strony 58–61

ISSN 2353–7752
e-ISSN 2353–7760

Wykorzystanie ultrasonografii płuc podczas kardiologicznej oceny osoby aktywnej fizycznie po przebytym COVID-19

Maria Binkiewicz-Orluk[1], Marcin Konopka[1], Agnieszka Jakubiak[2], Wojciech Król[1], Marek Kuch[2], Wojciech Braksator[1]

[1]Zakład Kardiologii Sportowej i Nieinwazyjnej Diagnostyki Kardiologicznej Warszawskiego Uniwersytetu Medycznego
[2]Klinika Kardiologii, Nadciśnienia Tętniczego i Chorób Wewnętrznych Warszawskiego Uniwersytetu Medycznego Mazowiecki Szpital Bródnowski, Warszawa

Artykuł jest tłumaczeniem pracy: Binkiewicz-Orluk M, et al. Lung ultrasound as a part of cardiological assessment of physically active person after COVID-19. 2022; 17(1): 54–57. DOI: 10.5603/FC.a2022.0002. Należy cytować wersję pierwotną

Streszczenie

Zarówno trwająca pandemia wywołana SARS CoV-2 (*severe acute respiratory syndrome coronavirus 2*), jak i zwiększająca się liczba ozdrowieńców po przebytej chorobie koronawirusowej 2019 (COVID-19, *coronavirus disease 2019*) stawia przed pracownikami ochrony zdrowia nowe wyzwania. Jednym z nich jest zaplanowanie oceny pacjentów po przebytym zakażeniu w celu bezpiecznego powrotu do aktywności zawodowej, fizycznej i społecznej oraz uniknięcia niezdiagnozowanych, potencjalnie zagrażających życiu powikłań. Istotnym elementem tej oceny jest dobór metod obrazowania ewolucji zmian śródmiąższowych płuc. Choć „złotym standardem" pozostaje badanie tomografii komputerowej klatki piersiowej wysokiej rozdzielczości, to zwiększa się zainteresowanie badaniem ultrasonograficznym płuc, które może stanowić jej wartościowe uzupełnienie i jest coraz chętniej wykonywane przy okazji badania echokardiograficznego. W publikacji zaprezentowano propozycję wykorzystania tej metody diagnostycznej u 34-letniego pacjenta, trenera sportowców na poziomie wyczynowym, po przebytym objawowym COVID-19, u którego istotne klinicznie zmiany śródmiąższowe wycofały się całkowicie w stosunkowo krótkim czasie.

Słowa kluczowe: ultrasonografia płuc, COVID-19, powikłania pocovidowe, medycyna sportowa

Folia Cardiologica 2022; 17, 1: 58–61

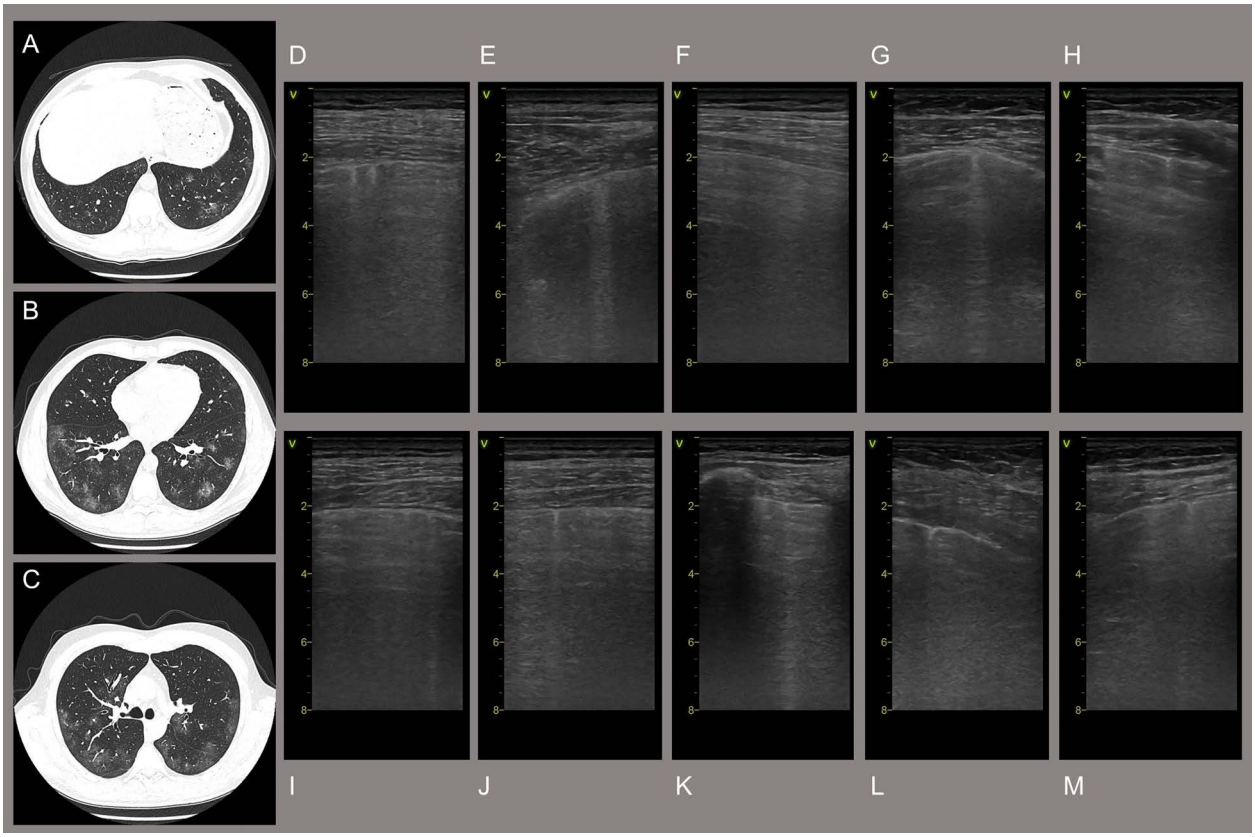
Opis przypadku

Aktywny fizycznie 34-letni mężczyzna, uprawiający sporty wyczynowe został przyjęty do szpitala w celu oceny po przebytej chorobie koronawirusowej 2019 (COVID-19, *coronavirus disease 2019*).

W wywiadzie odnotowano: w czasie infekcji — bóle mięśni i stawów, osłabienie, gorączka, kaszel (> 14 dni), duszność, spadki saturacji do 90%, bóle uciskowe w klatce piersiowej. Pacjent był leczony ambulatoryjnie, stosował leki przeciwgorączkowe.

Oceniony w 23. dobie od uzyskania dodatniego wyniku testu polimerazy reakcji łańcuchowej (PCR, *polymerase chain reaction*): klinicznie w stanie ogólnym dobrym, bez duszności i stenokardii. Parametry życiowe w normie, w badaniu elektrokardiograficznym (EKG) bradykardia zatokowa 52/min, zapis w normie dla osoby aktywnej fizycznie. W badaniach laboratoryjnych: leukopenia — 3,75 tys/µl (w rozmazie liczba neutrofili 1,51 tys/µl), podwyższona aktywność aminotransferazy alaninowej (ALT, *alanine aminotransferase*) — 199 j./l oraz asparaginianowej (AST, *aspartate aminotransferase*) — 60 j./l, zwiększone stężenie ferrytyny

Adres do korespondencji: lek. Maria Binkiewicz-Orluk, Zakład Kardiologii Sportowej i Nieinwazyjnej Diagnostyki Kardiologicznej, Warszawski Uniwersytet Medyczny, ul. Kondratowicza 8, 03–242 Warszawa, tel. +78 22 326 5505, e-mail: maria.binkiewicz@gmail.com



Rycina 1. Obrazowanie klatki piersiowej w 23. dobie od dodatniego testu polimerazy reakcji łańcuchowej (PCR, *polymerase chain reaction*) za pomocą różnych modalności: **A–C.** Tomografia komputerowa klatki piersiowej wysokiej rozdzielczości. Widoczne obustronnie rozsiane obszary matowej szyby zajmujące około 30% miąższu płuc; **D–M.** Badanie ultrasonograficzne płuc. Widoczne: 1) zmiany w zakresie linii opłucnej: nieregularności (**E, G–I, L, M**) oraz ubytki ciągłości (**L, M**), 2) drobne podopłucnowe konsolidacje z towarzyszącymi liniami C (**E, G, I–K**), 3) artefakty linii A (**F**)

— 361,1 ng/ml; stężenia N-końcowego fragmentu propeptydu natriuretycznego typu B (NT-proBNP, *N-terminal pro-B-type natriuretic peptide*), D-dimerów, wysokoczułej troponiny sercowej, białka C-reaktywnego oraz innych badań w normie. W surowicy pacjenta były obecne przeciwciała anty-SARS-CoV-2 (*severe acute respiratory syndrome coronavirus 2*) w klasie IgM 29,68 S/C (wartości pozytywne dla ≥ 1,4 S/C) oraz IgG 8,20 S/C (wartości pozytywne dla ≥ 1 S/C). W badaniu echokardiograficznym serca: prawidłowa geometria oraz proporcja jam serca, właściwe funkcje skurczowa i rozkurczowa obu komór, prawidłowy aparat zastawkowy, obecny ślad płynu w osierdziu. W 24-godzinnym zapisie EKG metodą Holtera średnia częstość rytmu serca 66/min, minimalna 44/min, maksymalna 120/min, nie zarejestrowano arytmii.

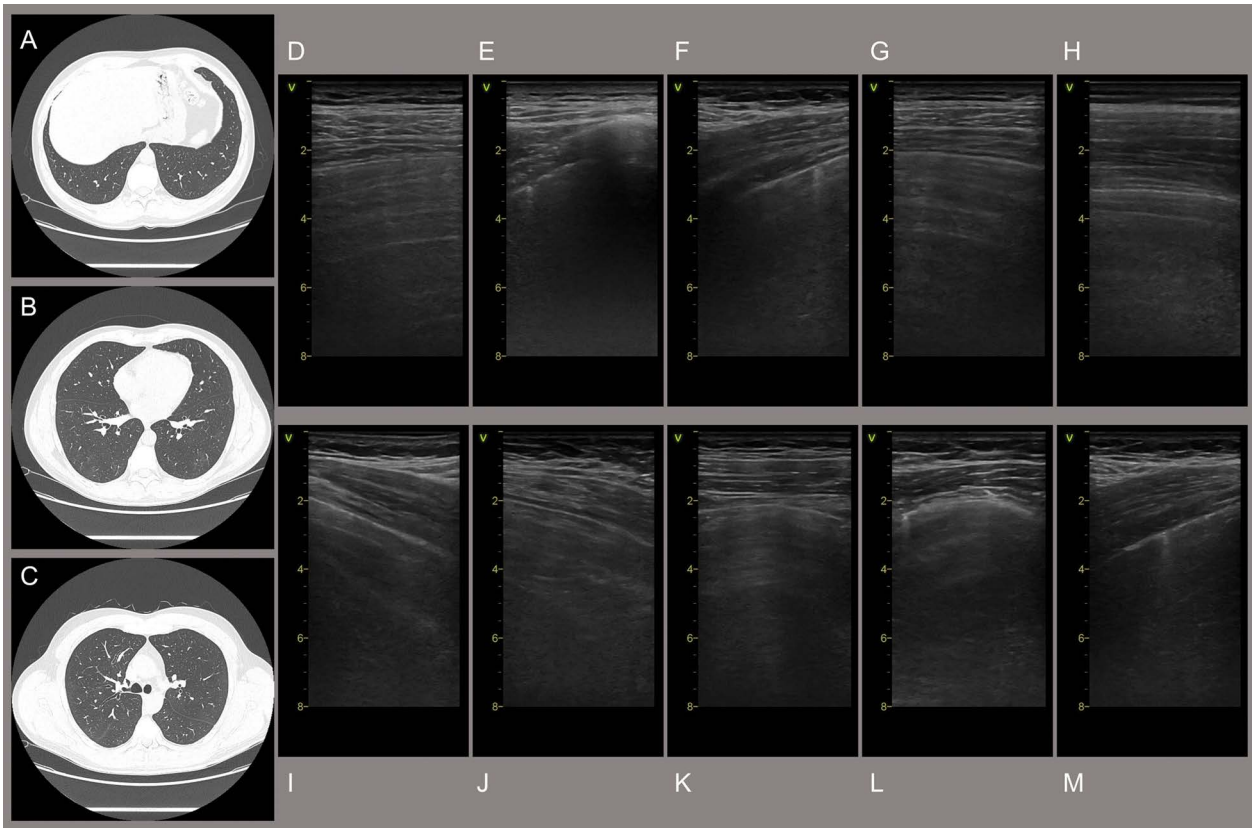
W badaniu ultrasonograficznym płuc (LUS, *lung ultrasound*) w większości obszarów uwidoczniono wiele nieprawidłowości. Były to: 1) nieregularność linii opłucnej oraz ubytki ciągłości; 2) liczne, niewielkie, podopłucnowe konsolidacje zapalne z towarzyszącymi liniami C (ryc. 1).

W badaniu tomografii komputerowej wysokiej rozdzielczości (HRCT, *high resolution computed tomography*) stwierdzono obszary matowej szyby, zajmujące około 30% miąższu płucnego. Ponadto uwidoczniono guzek o średnicy 3 mm w szczycie płuca prawego oraz niewielkie zrosty obustronnie w szczytach płuc i nadprzeponowo. Dodatkowo potwierdzono obecność płynu w osierdziu (do 10 mm), co korespondowało z obrazem echokardiograficznym.

Ze względu na nieprawidłowości w badaniach laboratoryjnych i obrazowych zalecono oszczędzający tryb życia, ćwiczenia oddechowe oraz samoobserwację.

Pacjent został ponownie oceniony po niespełna 11 tygodniach. W badaniach laboratoryjnych wykazano niewielkiego stopnia leukopenię (3,88 tys/µl) przy prawidłowym rozmazie, ponadto stwierdzono istotne zmniejszenie aktywności aminotransferaz (ALT 67 j./l, AST 24 j./l), normalizację stężenia ferrytyny, bez odchyleń w innych badaniach. Utrzymywało się dodatnie miano przeciwciał IgM (4,72 S/C) i IgG (7,32 S/C). W badaniu echokardiograficznym nie uwidoczniono obecnego wcześniej płynu w osierdziu.

W LUS stwierdzono istotną regresję widocznych wcześniej zmian — dominowały artefakty linii A świadczące o prawidłowym upowietrznieniu płuc, co korespondowało z obrazem uzyskanym w kontrolnej HRCT — obszary matowej szyby



Rycina 2. Obrazowanie klatki piersiowej w 99. dobie od dodatniego testu polimerazy reakcji łańcuchowej (PCR, *polymerase chain reaction*) za pomocą różnych modalności; **A–C.** Tomografia komputerowa klatki piersiowej wysokiej rozdzielczości. Znaczna regresja zmian w porównaniu z wcześniejszym badaniem: miąższ płucny bez istotnych zagęszczeń; **D–M.** Badanie ultrasonograficzne płuc: znaczna regresja zmian. Widoczne: 1) artefakty linii A (**D, G–K**), 2) nieregularność linii opłucnej (**E, F ,L, M**) oraz jej niewielkie ubytki (**E, F**), 3) drobne podopłucnowe konsolidacje z towarzyszącymi liniami C (**F, L, M**)

były widoczne jedynie na niewielkim obszarze w płacie dolnym prawego płuca (ryc. 2).

W celu uzupełnienia diagnostyki wykonano test wysiłkowy według protokołu Bruce'a — badanie zakończono po osiągnięciu tętna maksymalnego przy obciążeniu 16,5 ekwiwalentu metabolicznego (MET, *metabolic equivalent*) i zmęczeniu 9/10 pkt. w zmodyfikowanej skali Borga, co potwierdziło bardzo dobrą tolerancję wysiłku.

Pacjent powrócił do pełnej sprawności zawodowej oraz aktywności fizycznej.

Dyskusja

Kolejnym wyzwaniem, które przed pracownikami ochrony zdrowia stawia pandemia SARS CoV-2 (*severe acute respiratory syndrome coronavirus 2*), jest zapewnienie bezpieczeństwa rekonwalescencji — powrotu do pracy zawodowej oraz aktywności fizycznej.

U sportowców szczególną rolę odgrywa ocena układu krążenia, która pozwala na wczesne rozpoznanie groźnych dla życia powikłań (zatorowości płucnej, ostrych zespołów wieńcowych, arytmii, zapalenia mięśnia sercowego, zapalenia osierdzia czy niewydolności serca) [1]. Schematy oceny kardiologicznej są dostępne w piśmiennictwie pod postacią protokołów *return-to-play* [2]. Choć nieznacznie różnią się między sobą, to w każdym z nich rekomenduje się diagnostykę kardiologiczną u pacjentów z objawami przed powrotem do intensywnych treningów: postępowanie zależy od długości trwania i natężenia objawów. W amerykańskich wytycznych zaleca się wykonanie badań laboratoryjnych, w tym oznaczenie stężenia troponiny oraz przeprowadzenie badania elektro- i echokardiograficznego; w zależności od wyników należy rozważyć wykonanie innych badań, w tym rezonansu magnetycznego serca. W innych protokołach padają sugestie dotyczące wykonania 24-godzinnego badania EKG metodą Holtera i testów wysiłkowych, w tym badania spiroergometrycznego. Wobec braku ujednoliconych wytycznych duże znaczenie mają decyzje indywidualne.

W opisywanym przypadku wykonano wiele badań kardiologicznych (laboratoryjne, echokardiograficzne, EKG metodą Holtera, test wysiłkowy), w których nie stwierdzono istotnych nieprawidłowości.

Obawy dotyczące możliwości rozwoju włóknienia płuc jako formy zejściowej zmian śródmiąższowych znajdują odzwierciedlenie w doświadczeniach poprzednich epidemii spowodowanych koronawirusami zespołu ostrej ciężkiej niewydolności oddechowej (SARS, *severe acute respiratory syndrome*) i bliskowschodniego zespołu niewydolności oddechowej (MERS, *Midle East respiratory syndrome*) [3]. Istnieją dane wskazujące, że zmiany w HRCT typowe dla COVID-19 (obraz matowej szyby, kostki brukowej, konsolidacje zapalne, pasmowate zmiany podopłucnowe) utrzymują się aż u 77% osób po 2 miesiącach i u 63% po 3 miesiącach od zakażenia [4].

Dostępność zmian charakterystycznych dla COVID-19 dla ultradźwięków, brak ekspozycji na promieniowanie jonizujące, stosunkowo wysoka czułość, powtarzalność, możliwość przyłóżkowego wykonania badania oraz szybka krzywa uczenia się sprawiły, że znacznie wzrosło zainteresowanie ultrasonografią płuc [5]. Z kardiologicznego punktu widzenia dodatkową zaletą jest możliwość szybkiej przesiewowej oceny miąższu płuc podczas badania echokardiograficznego. Pozycja tej metody w ocenie aktywnej COVID-19 u pacjentów hospitalizowanych została ugruntowana w piśmiennictwie [6], godne podkreślenia są również obiecujące wyniki dotyczące wykorzystania LUS w ocenie ewolucji zmian w celu rozpoznania choroby śródmiąższowej oraz innych powikłań — według niektórych autorów LUS powinno być badaniem pierwszego rzutu [5].

Do typowych zmian ultrasonograficznych w przebiegu COVID-19 należą: nieregularna i/lub przerwana linia opłucnej, artefakty linii B i konsolidacje zapalne (mniejsze podopłucnowe, z towarzyszącymi liniami C, lub większe — płatowe). W fazie zdrowienia obserwuje się stopniową regresję wymienionych wyżej nieprawidłowości, czego wyrazem jest zwiększenie liczby obszarów z artefaktami linii A, będących odzwierciedleniem prawidłowo upowietrznionego miąższu płucnego [5], co znalazło potwierdzenie w opisywanym przypadku.

Wnioski

Ocena pacjentów po przebytej COVID-19 jest zasadna ze względu na możliwość wystąpienia powikłań dotyczących różnych narządów i układów. Przesiewowe badania kardiologiczne można przeprowadzić, używając dostępnych protokołów *return-to-play*. Zarówno HRCT, jak i LUS są właściwymi metodami pozwalającymi ocenić ewolucję zmian śródmiąższowych po przebytej COVID-19.

Konflikt interesów

Autorzy nie zgłaszają konfliktu interesów.

Finansowanie

Brak.

Piśmiennictwo

1. Madjid M, Safavi-Naeini P, Solomon SD, et al. Potential effects of coronaviruses on the cardiovascular system: a review. JAMA Cardiol. 2020; 5(7): 831–840, doi: 10.1001/jamacardio.2020.1286, indexed in Pubmed: 32219363.
2. Phelan D, Kim JH, Chung EH. A game plan for the resumption of sport and exercise after coronavirus disease 2019 (COVID-19) infection. JAMA Cardiol. 2020; 5(10): 1085–1086, doi: 10.1001/jamacardio.2020.2136, indexed in Pubmed: 32402054.
3. Chan KS, Zheng JP, Mok YW, et al. SARS: prognosis, outcome and sequelae. Respirology. 2003; 8(Suppl): S36–S40, doi: 10.1046/j.1440-1843.2003.00522.x, indexed in Pubmed: 15018132.
4. Sonnweber T, Sahanic S, Pizzini A, et al. Cardiopulmonary recovery after COVID-19: an observational prospective multicentre trial. Eur Respir J. 2020; 57(4): 2003481, doi: 10.1183/13993003.03481-2020.
5. Peixoto AO, Costa RM, Uzun R, et al. Applicability of lung ultrasound in COVID-19 diagnosis and evaluation of the disease progression: a systematic review. Pulmonology. 2021; 27(6): 529–562, doi: 10.1016/j.pulmoe.2021.02.004, indexed in Pubmed: 33931378.
6. Treanor L, Islam N, Ebrahimzadeh S, et al. The cochrane systematic review on thoracic imaging tests for the diagnosis of COVID-19. Radiology. 2021; 299(3): E289, doi: 10.1148/radiol.2021210564, indexed in Pubmed: 33754831.

CASE REPORT

Folia Cardiologica 2022
vol. 17, no. 1, pages 62–64
DOI: 10.5603/FC.2022.0009

ISSN 2353–7752
e-ISSN 2353–7760

Left ventricular non-compaction cardiomyopathy, a rare cause of cardiovascular complaints

Azita Rezaei[1], Marcin Gregorczyk[1], Agnieszka Ciba-Stemplewska[2], Katarzyna Starzyk[3], Wioletta Korzeluch[4], Michał Spałek[5, 6], Beata Wożakowska-Kapłon[1, 3]

[1]Faculty of Medicine and Health Sciences, *Collegium Medicum*, Jan Kochanowski University in Kielce, Poland
[2]Department of Internal Medicine, Regional Polyclinical Hospital in Kielce, Poland
[3]1st Department of Cardiology and Electrotherapy, Świętokrzyskie Cardiology Centre, Regional Polyclinical Hospital in Kielce, Poland
[4]Cardiology Outpatient Clinic, Świętokrzyskie Paediatric Centre, Regional Polyclinical Hospital in Kielce, Poland
[5]Institute of Anatomy, Collegium Medicum, Jan Kochanowski University in Kielce, Poland
[6]Institute of Diagnostic Imaging, Holy Cross Cancer Centre in Kielce, Poland

Abstract

20-year-old woman with diagnosed in childhood left ventricular non-compaction (LVNC) cardiomyopathy with coexisting arthrogryposis was admitted to the Department of Cardiology due to atypical chest pain, worsening of exercise tolerance, bendopnea and symptoms of bronchial asthma exacerbation. The electrocardiogram (ECG) showed changes indicative of ischemia, without their dynamics. Inflammatory parameters, BNP (B-type natriuretic peptide), and myocardial necrosis markers were not elevated. Systolic and diastolic function on echocardiography (ECHO) was assessed as normal. Despite the initially suggestive clinical picture, the correct direction of the differential diagnosis, and consequently the diagnosis, was established after completing the history of comorbidities.

Key words: LVNC, cardiomyopathy, arthrogryposis

Folia Cardiologica 2022; 17, 1: 62–64

Introduction

Left ventricular non-compaction cardiomyopathy (LVNC) is a rare congenital disease that can occur familially and spontaneously [1]. The prevalence is 0.05–0.26% of all adults referred for echocardiography and 3–4% of patients with heart failure (HF) [2].

During the embryonic period, the myocardium is a trabecular structure, supplied with blood in the intertrabecular spaces called sinusoids (recesses). With the development of coronary circulation in the pericardium, the sinusoids disappear and the walls of the ventricles transform into a compact muscle. This process proceeds beginning from the base of the heart and ending at its apex. In LVNC, this process is disrupted. As a result, hearts with LVNC are characterised by excessive trabeculation and deep intertrabecular sinusoids. Although coronary circulation is normal, wall structure abnormalities may adversely affect myocardial wall perfusion, causing ischaemia and leading to thromboembolic incidents, arrhythmias, or heart failure [3]. Treatment consists mainly of preventing these complications. Genetic mutations are cited as the cause, with 60% of them being spontaneous. The rest of the cases are autosomal

Address for correspondence: Azita Rezaei, Wydział Lekarski i Nauk o Zdrowiu, *Collegium Medicum,* Uniwersytet Jana Kochanowskiego w Kielcach, aleja IX Wieków Kielc 19A, 25–317 Kielce, Poland, e-mail: azita.rezaei91@gmail.com

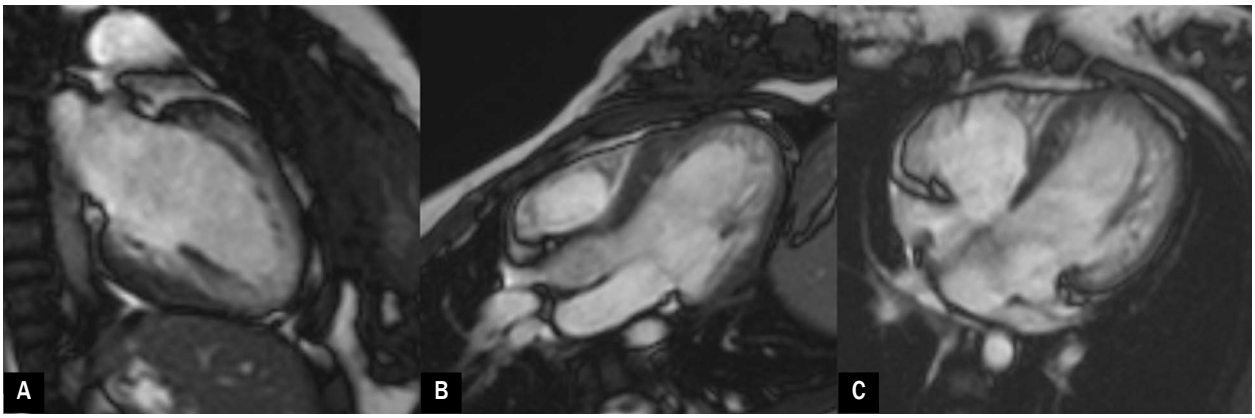


Figure 1. An magnetic resonance image showing increased trabeculation; **A.** 2-chamber view; **B.** 3-chamber view; **C.** 4-chamber view

dominant mutations with incomplete penetrance or coupled to the X chromosome (e.g. Barth syndrome) [2]. Mutations affect sarcomeric genes that are common causes of hypertrophic and dilated cardiomyopathy: *MYH7*, *MYBPC3*, *TTN*.

There are four subtypes of LVNC, provided that the dimensions of the left ventricle (LV) are known:

- isolated LVNC (if LV dimensions are normal, without hypertrophy);
- LVNC with hypertrophic cardiomyopathy (if LV wall thickness is ≥ 13 mm, or there was a previous diagnosis of hypertrophy);
- LVNC with dilated cardiomyopathy (if there is an enlargement of LV);
- LVNC with hypertrophic and dilated cardiomyopathy (when there are features of both increased LV wall thickness and enlargement of LV) [4].

The main tools in the diagnosis of LVNC are echocardiography and magnetic resonance imaging (MRI) (Figure 1). These methods enable the detection of the presence of two layers of the myocardium: a thin — compact (outer) layer and a thicker — non-compact (inner) layer, located mainly in the LV apex and the middle segments of the inferior and lateral wall. In addition, there is increased LV trabeculation with deepening of the intertrabecular sinuses, deeply perfused as seen on colour Doppler.

The most commonly used are the echocardiographic criteria proposed by Jenni et al. [5]:

- a characteristic image of multiple, excessive trabeculation with deep intertrabecular folds;
- intertrabecular spaces filled with blood flowing directly from LV cavity on colour Doppler imaging;
- a ratio of non-compacted to compacted layer thickness higher than 2 (measured in end-systolic phase, parasternal short axis view);
- no other cardiac anomalies.

The diagnostic criteria in MR are also based on calculating the ratio of non-compacted to compacted layer thickness with a cut-off point ≥ 2.3 for diagnosis [2].

Case study

A 20-year-old woman was admitted to the Cardiology Department due to exertional dyspnoea, weakness, fever (up to 38.8°), reduced exercise capacity corresponding to New York Heart Association (NYHA) class II/III along with stabbing chest pain for several days. The patient had comorbidities: bronchial asthma and arthrogryposis (a congenital multi-joint contracture disease). The patient had a history of pain and moderate exertional dyspnoea due to comorbidities.

The diagnosis of LVNC was made at the age of fourteen when she presented to her doctor because of reduced exercise tolerance and chest pain. At that time, ECG showed ST-segment depression, while echocardiogram revealed trace tricuspid regurgitation with right ventricle–right atrium (RV–RA) gradient, concentric LV hypertrophy with hypertrophied endocardium, right ventricular apical hypertrophy, markedly reduced contractility of the basal region. The family history was negative.

Laboratory tests were performed on admission. Inflammatory markers, markers of myocardial necrosis, and BNP were all within the normal range.

An ECG was performed which showed: sinus rhythm, J-point elevation in V1–V3 leads, with flat T-waves in I, II, aVL, and V5–V6 leads (Figure 2). Neither the dynamics of ECG changes nor elevated levels of markers of myocardial necrosis were observed.

No significant LV systolic dysfunction or segmental wall motion abnormalities were observed on the echocardiogram. The only abnormality was the increased trabeculation characteristic of LVNC.

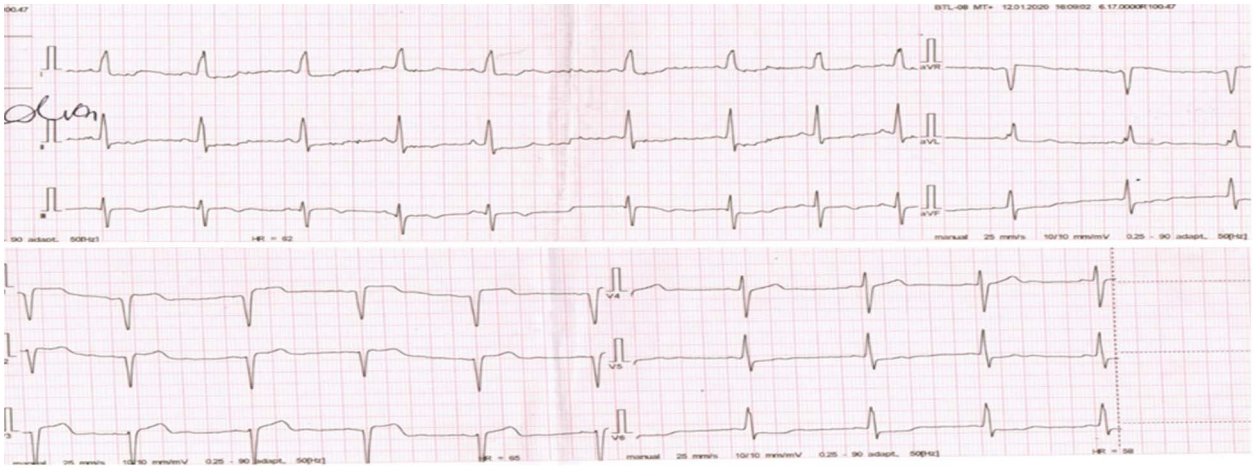


Figure 2. Electrocardiogram on admission: sinus rhythm, J-point elevation in V1–V3 leads, with flat T-waves in I, II, aVL, aVF, and V5–V6 leads

Discussion

The case described reflects the difficulties in differential diagnosis and the management of treatment. Patients with LVNC, as in this case, may have persistent ECG changes. Therefore, in order to rule out newly developed disorders, results should be compared with previous ones, if available. Likewise, heart failure, common in LVNC, was ruled out by echocardiography and by normal BNP levels.

Other causes of reported complaints were therefore taken into account:

— infectious exacerbation of bronchial asthma (increased spasticity over the lung fields, fever);
— pain associated with musculo-articular disorders.

Conclusions

LVNC, like arthrogryposis, is a rare disease. LVNC may present individually differentiated ECG changes: features of LV or left atrial hypertrophy, ventricular repolarisation abnormalities, signs of preexcitation. Dyspnoea may result from LV systolic dysfunction, arrhythmias, thromboembolic complications. ECG and echocardiography, due to their availability, are fundamental in establishing the correct diagnostic procedure. If new symptoms appear, the medical history should also be carefully taken and co-morbidities should be taken into account. In the described patient, despite a diagnosis suggestive of rare cardiomyopathy, her complaints were caused by an infectious exacerbation of bronchial asthma and musculoskeletal disorders.

Conflict of interest

The authors declare no conflicts of interest.

Funding

None.

References

1. Singh DP, Patel H. Left ventricular non-compaction cardiomiopathy. StatPearls Publishing 2021. https://www.ncbi.nlm.nih.gov/books/NBK537025/ (July 10, 2021).
2. Ponikowski P, Hoffman P, Witkowski A. ed. Kardiologia. Podręcznik Polskiego Towarzystwa Kardiologicznego. Via Medica, Gdańsk 2019: 478, 488.
3. Ichida F. Left ventricular noncompaction — risk stratification and genetic consideration. J Cardiol. 2020; 75(1): 1–9, doi: 10.1016/j.jjcc.2019.09.011, indexed in Pubmed: 31629663.
4. van Waning JI, Moesker J, Heijsman D, et al. Systematic review of genotype-phenotype correlations in noncompaction cardiomyopathy. J Am Heart Assoc. 2019; 8(23): e012993, doi: 10.1161/JAHA.119.012993, indexed in Pubmed: 31771441.
5. Oechslin E, Jenni R. Left ventricular non-compaction revisited: a distinct phenotype with genetic heterogeneity? Eur Heart J. 2011; 32(12): 1446–1456, doi: 10.1093/eurheartj/ehq508, indexed in Pubmed: 21285074.

Folia Cardiologica 2022
tom 17, nr 1, strony 65–67

ISSN 2353–7752
e-ISSN 2353–7760

Kardiomiopatia z niescalenia lewej komory — rzadka przyczyna dolegliwości ze strony układu krążenia

Azita Rezaei[1], Marcin Gregorczyk[1], Agnieszka Ciba-Stemplewska[2], Katarzyna Starzyk[3], Wioletta Korzeluch[4], Michał Spałek[5, 6], Beata Wożakowska Kapłon[1, 3]

[1]Wydział Lekarski i Nauk o Zdrowiu *Collegium Medicum* Uniwersytetu Jana Kochanowskiego w Kielcach
[2]Klinika Chorób Wewnętrznych Wojewódzkiego Szpitala Zespolonego w Kielcach
[3]I Klinika Kardiologii i Elektroterapii Świętokrzyskiego Centrum Kardiologii, Wojewódzki Szpital Zespolony w Kielcach
[4]Poradnia Kardiologiczna Świętokrzyskiego Centrum Pediatrii, Wojewódzki Szpital Zespolony w Kielcach
[5]Zakład Anatomii Collegium Medicum Uniwersytetu Jana Kochanowskiego w Kielcach
[6]Zakład Diagnostyki Obrazowej Świętokrzyskiego Centrum Onkologii w Kielcach

Artykuł jest tłumaczeniem pracy: Rezaei A, et al. Left ventricular non-compaction cardiomyopathy: a rare cause of cardiovascular complaints. Folia Cardiologica 2022; 17(1): 62–64. DOI: 10.5603/FC.2022.0009. Należy cytować wersję pierwotną

Streszczenie

Kobieta w wieku 20 lat, z rozpoznaną w dzieciństwie kardiomiopatią z niescalenia lewej komory towarzyszącą artrogrypozie, została przyjęta na oddział kardiologii z powodu nietypowego bólu w klatce piersiowej, pogorszenia tolerancji wysiłku fizycznego, *bendopnea* oraz objawów zaostrzenia astmy oskrzelowej. W zapisie elektrokardiograficznym stwierdzono zmiany wskazujące na niedokrwienie, bez ich dynamiki. Parametry zapalne, stężenie peptydu natiuretycznego typu B oraz markery martwicy miokardium nie były podwyższone. Funkcje skurczową i rozkurczową w badaniu echokardiograficznym oceniono jako prawidłową. Mimo początkowo sugestywnego obrazu klinicznego właściwy kierunek diagnostyki różnicowej i w efekcie rozpoznanie ustalono po uzupełnieniu wywiadu dotyczącego chorób współistniejących.

Słowa kluczowe: LVNC, kardiomiopatia, artrogrypoza

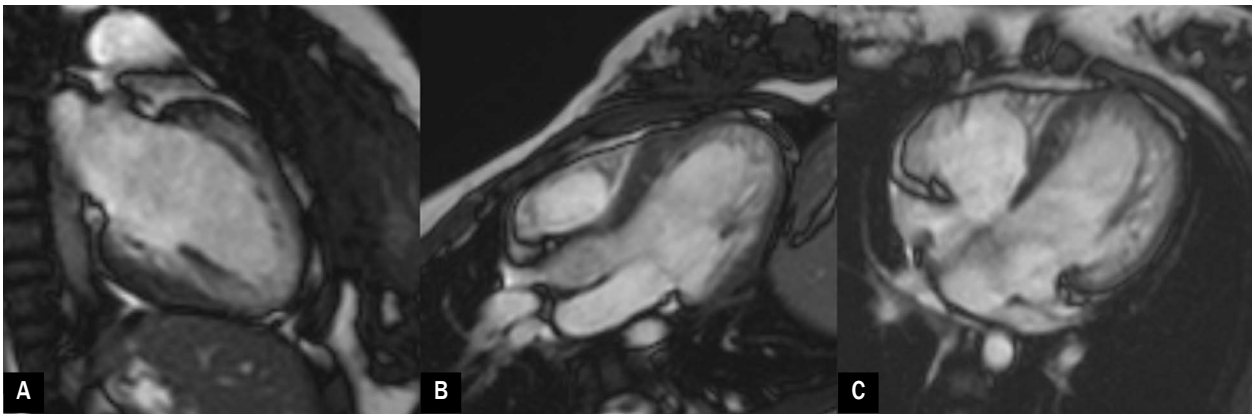
Folia Cardiologica 2022; 17, 1: 65–67

Wstęp

Kardiomiopatia z niescalenia lewej komory (LVNC, *left ventricular non-compaction*) jest rzadką chorobą wrodzoną, która może występować rodzinnie i spontanicznie [1]. Częstość występowania wynosi 0,05–0,26% u wszystkich dorosłych kierowanych na badanie echokardiograficzne oraz 3–4% wśród chorych z niewydolnością serca (HF, *heart failure*) [2].

W okresie embrionalnym mięsień sercowy jest strukturą beleczkowatą, zaopatrywaną przez krew znajdująca się w przestrzeniach międzybeleczkowych, sinusoidach (zachyłkach).Wraz z powstaniem krążenia wieńcowego w osierdziu dochodzi do zaniku sinusoid i przekształcenia ścian komór w zwarty mięsień. Proces ten postępuje w kolejności od podstawy do koniuszka serca. W LVNC proces ten jest zaburzony. W efekcie serca z LVNC charakteryzuje nadmierne beleczkowanie i głębokie sinusoidy międzybeleczkowe. Mimo że krążenie wieńcowe jest prawidłowe, to zaburzenia w budowie ściany mogą niekorzystnie wpływać na perfuzję wewnątrzścienną, powodując niedokrwienie oraz prowadzić do incydentów zakrzepowo-zatorowych, arytmii czy HF [3]. Leczenie polega głównie na zapobieganiu tym powikłaniom. Za przyczynę podaje się mutacje genetyczne,

Adres do korespondencji: Azita Rezaei, Wydział Lekarski i Nauk o Zdrowiu, *Collegium Medicum,* Uniwersytet Jana Kochanowskiego w Kielcach, aleja IX Wieków Kielc 19A, 25–317 Kielce, e-mail: azita.rezaei91@gmail.com



Rycina 1. Obraz rezonansu magnetycznego z widocznym wzmożonym beleczkowaniem; **A.** projekcja dwujamowa (2CH, *two-chamber*); **B.** Projekcja trójjamowa (3CH, *three-chamber*); **C.** Projekcja czterojamowa (4CH, *four-chamber*)

spośród których 60% jest spontanicznych. W pozostałych przypadkach są to mutacje autosomalne dominujące z niepełną penetracją lub sprzężone z chromosomem X (np. zespół Bartha) [2]. Mutacje dotyczą genów sarkomerowych, które są częstymi przyczynami kardiomiopatii przerostowej i rozstrzeniowej: *MYH7, MYBPC3, TTN*.

Wyróżniono cztery podtypy LVNC identyfikowane pod warunkiem, ze znane są wymiary lewej komory (LV, *left ventricle*):

— Izolowana LVNC (jeśli wymiary LV są prawidłowe, bez hipertrofii);
— LVNC z kardiomiopatią przerostową (jeśli grubość ściany LV ≥13 mm albo wcześniejsza diagnoza hipertrofii);
— LVNC z kardiomiopatią rozstrzeniową (jeśli wymiary LV są powiększone);
— LVNC z kardiomiopatią przerostową i rozstrzeniową (gdy występują cechy zarówno zwiększenia grubości ściany LV, jak i powiększenie wymiarów LV) [4].

Głównymi narzędziami w diagnostyce LVNC są badanie echokardiograficzne oraz obrazowanie metodą rezonansu magnetycznego (MRI, *magnetic resonance imaging*) (ryc. 1). Diagnostyka polega na wykazaniu obecności dwóch warstw miokardium: cienkiej — scalonej (zewnętrznej) oraz grubszej — niescalonej (wewnętrznej) zlokalizowanej głównie w koniuszku LV oraz w segmentach środkowych ścian dolnej i bocznej. Ponadto widać wzmożone beleczkowanie LV z pogłębieniem zatok międzybeleczkowych, głęboko perfundowanych w badaniu metodą kolorowego doplera.

Najczęściej stosuje się kryteria echokardiograficzne Jenni i wsp. [5]:

— charakterystyczny obraz licznego, nadmiernego beleczkowania z głębokimi miedzybeleczkowanymi zachyłkami;
— przestrzenie międzybeleczkowe wypełnione krwią wpływająca bezpośrednio z jamy LV ujawnione w obrazowaniu w badaniu metodą kolorowego doplera;
— stosunek grubości warstwy niescalonej do scalonej przekracza 2 (pomiar w fazie końcowo-skurczowej, w projekcji przymostkowej w osi krótkiej);
— brak innych anomalii serca.

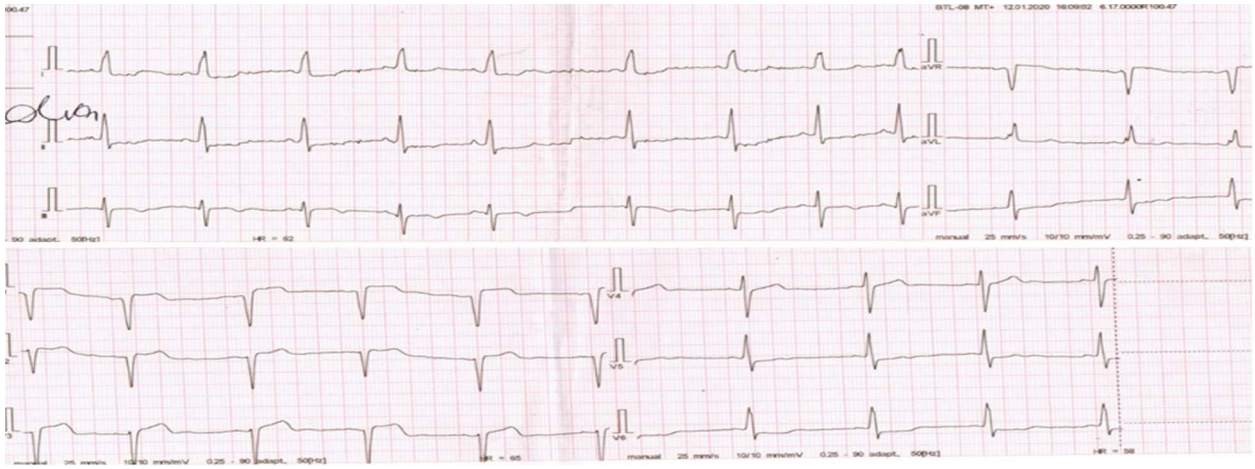
Podstawą kryteriów diagnostycznych w MRI również stanowi wartość stosunku grubości warstwy niescalonej do scalonej z punktem odcięcia większym lub równym 2,3 dla rozpoznania [2].

Opis przypadku

20-letnią kobieta została przyjęta na oddział kardiologii z powodu duszności wysiłkowej, osłabienia, gorączki (do 38,8°C), obniżenia wydolności wysiłkowej odpowiadającej II/III klasie niewydolności serca według *New York Heart Association* (NYHA) wraz z kłującym bólem w klatce piersiowej od kilku dni. Pacjentka miała choroby współistniejące: astma oskrzelowa oraz artrogrypoza (choroba polegająca na wrodzonym występowaniu wielostawowych przykurczy). Pacjentka w przeszłości zgłaszała dolegliwości bólowe oraz duszność wysiłkową o umiarkowanym stopniu, na tle chorób współistniejących.

Rozpoznania LVNC dokonano w 14. roku życia, gdy zgłosiła się lekarza z powodu obniżenia tolerancji wysiłku oraz bólu w klatce piersiowej. Wówczas w EKG zostało zaobserwowane obniżenie odcinka ST, natomiast w echokardiografii stwierdzono śladowaą niedomykalność zastawki trójdzielnej z gradientem prawa komora–prawy przedsionek (RV-RA, *right ventricle–right atrium*), koncentryczny przerost LV z rozbudowanym wsierdziem, przerost koniuszka prawej komory, wyraźnie obniżona kurczliwość okolicy przypodstawnej. Wywiad rodzinny nie był obciążający.

Przy przyjęciu przeprowadzono badania laboratoryjne. Wskaźniki stanu zapalnego, markery martwicy miokardium i stężenie peptydu natriuretycznego typu B (BNP, *B-type natriuretic peptide*) były w zakresie prawidłowych wartości.



Rycina 2. Badanie elektrokardiograficzne przy przyjęciu: rytm zatokowy, wysokie odejście punktu J w odprowadzeniach V1–V3, z płaskimi T w odprowadzeniach I, II, aVL, aVF oraz V5, V6

W badaniu EKG wykonanym przy przyjęciu wykazano: rytm zatokowy, wysokie odejście punktu J odprowadzeniach V1–V3, z płaskimi T w dprowadzeniach I, II, aVL, aVF oraz V5, V6 (ryc. 2). Nie zaobserwowano dynamiki zmian w zapisie EKG ani narastania markerów martwicy miokardium.

W badaniu echokardiograficznym nie obserwowano istotnej dysfunkcji skurczowej LV ani odcinkowych zaburzeń kurczliwości. Jedyna nieprawidłowością było wzmożone beleczkowanie charakterystyczne dla LVNC.

Dyskusja

Opisany przypadek odzwierciedla trudności w diagnostyce różnicowej i postępowaniu w leczeniu. U chorych z LVNC, tak jak w tym przypadku, mogą występować przetrwałe zmiany w zapisie EKG. Dlatego, aby wykluczyć nowo powstałe zaburzenia, należy porównać wyniki z poprzednimi, o ile są dostępne. Niewydolność serca, podobnie często występującą w LVNC, wykluczono w w badaniu echokardiograficznym oraz na podstawie prawidłowego stężenia BNP. Dlatego uwzględniono inne przyczyny zgłaszanych dolegliwości:

— infekcyjne zaostrzenie astmy oskrzelowej (nasilenie spastyki nad polami płucnymi, gorączka);
— ból związany z zaburzeniami mięśniowo-stawowymi.

Podsumowanie

Podobnie jak artrogrypoza LVNC jest chorobą rzadką. W LVNC mogą występować indywidualnie zróżnicowane zmiany w zapisie EKG: cechy przerostu LV lub lewego przedsionka, nieprawidłowości okresu repolaryzacji komór, cechy preekscytacji. Duszność może wynikać z dysfunkcji skurczowej LV, zaburzeń rytmu, powikłań zakrzepowo-zatorowych. Badanie EKG oraz echokardiograficzne, ze względu na dostępność, stanowią podstawę w ustalaniu prawidłowej diagnozy. W przypadku pojawienia się nowych objawów należy także dokładnie uzupełnić dane z wywiadu lekarskiego oraz uwzględnić współchorobowość. U opisywanej pacjentki, mimo sugestywnego rozpoznania rzadkiej kardiomiopatii, przyczyną dolegliwości było infekcyjne zaostrzenie astmy oskrzelowej oraz zaburzenia kostno-mięśniowe.

Konflikt interesów

Autorzy nie zgłaszają konfliktu interesów.

Finansowanie

Brak.

Piśmiennictwo

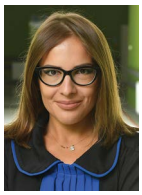
1. Singh DP, Patel H. Left ventricular non-compaction cardiomiopathy. StatPearls Publishing 2021. https://www.ncbi.nlm.nih.gov/books/NBK537025/ (July 10, 2021).
2. Ponikowski P, Hoffman P, Witkowski A. ed. Kardiologia. Podręcznik Polskiego Towarzystwa Kardiologicznego. Via Medica, Gdańsk 2019: 487, 488.
3. Ichida F. Left ventricular noncompaction — risk stratification and genetic consideration. J Cardiol. 2020; 75(1): 1–9, doi: 10.1016/j.jjcc.2019.09.011, indexed in Pubmed: 31629663.
4. van Waning JI, Moesker J, Heijsman D, et al. Systematic review of genotype-phenotype correlations in noncompaction cardiomyopathy. J Am Heart Assoc. 2019; 8(23): e012993, doi: 10.1161/JAHA.119.012993, indexed in Pubmed: 31771441.
5. Oechslin E, Jenni R. Left ventricular non-compaction revisited: a distinct phenotype with genetic heterogeneity? Eur Heart J. 2011; 32(12): 1446–1456, doi: 10.1093/eurheartj/ehq508, indexed in Pubmed: 21285074.

Folia Cardiologica 2022
vol. 17, no. 1, pages 68–72
DOI: 10.5603/FC.2022.0012

ISSN 2353–7752
e-ISSN 2353–7760

Physician's legal liability for making a patient becomes infected with SARS-CoV-2

Odpowiedzialność prawna lekarza za zakażenie się pacjenta SARS-CoV-2



Kamila Kocańda[1], Patrycja Aleksandrowicz[2], Dorota Zarębska-Michaluk[1]

[1]Institute of Medical Sciences of the Jan Kochanowski University in Kielce, Kielce, Poland
[2]Jan Kochanowski University in Kielce, Kielce, Poland

Abstract

The coronavirus epidemic, lasting from the end of 2019, which quickly gained proportions and the status of a pandemic, has changed the reality in health care for a long time, not only radically testing the endurance of medical personnel and the efficiency of the health system, but also forcing its significant and immediate rearrangement. In the period of the greatest number of infections, in view of disease outbreaks in healthcare facilities, a decision to limit access to health care services both in a timely justified for health reasons (postponement of scheduled admissions) and in a medically optimal form (telephone medical advice) could expose a patient to negative health effects, even though it was epidemiologically justified. The choice between epidemiological risks and patient's exposure to health consequences due to failure to provide a health care service on time or form was burdening managers of healthcare facilities and their medical personnel. In the light of the above, a decision to provide a health care service as part of hospitalisation was inherently associated with an increased risk of severe acute respiratory syndrome coronavirus (SARS-CoV-2) infection during a hospital stay, which justifies the legal analysis of the possibility of classifying SARS-CoV-2 infection as hospital-acquired infections and all legal consequences related to them.

Key words: coronavirus infection, hospital-acquired infection, infection prevention, infection combating

Folia Cardiologica 2022; 17, 1: 68–72

Introduction

Due to the new epidemiological realities in which it has become necessary to provide health care services of all kinds under the conditions of a pandemic, a dynamic arrangement of the various stages of the process of providing health care services became justified [1]. It was subject to significant changes through the spread of telephone medical advice, transformation of health care facilities into single-name hospitals, creating so-called temporary hospitals, or implementing new standards of medical procedure in the field of preventing and combating severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. It also turned out to be necessary to limit certain rights of patients, including the right to contact with relatives and access to health care services. According to the Report by the Patient Ombudsman [2], the number of written petitions submitted to this authority

Address for correspondence: Doctor of Juridical Science Kamila Kocańda, Instytut Nauk Medycznych, Uniwersytet Jana Kochanowskiego, ul. IX Wieków Kielc 19, 25–317 Kielce, Poland, e-mail: kamila.kocanda@gmail.com

in September 2020 was 1 063. In the corresponding period of 2019, it was 482. Among the petitions submitted from January to September 2020, 71% was concerning the restriction of the right to health care services or their improper implementation in health care facilities; another 29% was connected with objections against a long waiting time for specialist services, comprehensiveness, and diligence of the health care services provided, as well as limited access to diagnostics. Among the petitions addressed to the Patient Ombudsman's Office and directly to health care facilities, there were also requests for explanations of circumstances of patients' infections with SARS-CoV-2 during hospitalisation caused by another disease. Currently, the first payment requests are recorded in health care facilities, which are an announcement of future civil actions for payment or notifications to law enforcement authorities regarding SARS-CoV-2 infection during a stay in hospital related to routine treatment or elective surgery.

SARS-CoV-2 hospital-acquired infection

Pursuant to Art. 2 sec. 33 of the Act on preventing and combating infections and infectious diseases in humans [3], a hospital-acquired infection is an infection that occurred during the provision of health care services when a disease is not in a period of incubation at the time of or does not occur after providing health care services in the period not longer than the longest incubation period. In the light of the presented legal definition, a hospital-acquired infection may be a consequence of a lack of diligence in performing medical procedures, non-compliance with current medical knowledge, as well as a result of the improper organisation of the process of providing health care services in a health care facility. The risk of coronavirus infection in connection with a stay in a health care facility in 24/7 conditions was associated with several factors.

Firstly, health care facilities did not have a sufficient number of single-person rooms, isolation rooms, airlocks, and other spatial conditions which would allow optimal isolation of patients with suspected infections, especially since the number of so-called asymptomatic patients made every patient a potential suspect of infection, although not everyone exhausted a legal definition of a suspect within the meaning of the Act on preventing and combating infections and infectious diseases in human [4].

Secondly, the specificity of SARS-CoV-2 infection and a significant number of asymptomatic patients supported the use of polymerase chain reaction (PCR) testing method [5], which, thanks to greater sensitivity, can definitely more accurately verify the epidemiological status of a patient, whereas this type of test is not always possible due to the need to immediately provide the patient with emergency medical care. For these reasons, antigen tests have become the more commonly used diagnostic method in hospital emergency departments and emergency rooms [6]. At the same time, a patient who was hospitalised in an emergency mode of hospital admission and was diagnosed and subjected to various types of medical procedures, after disclosing the fact of infection, he or she was subjected to isolation procedures. However, it was not possible to remove the epidemiological effects of his or her diagnosis and treatment in the structure of the entire health care facility in light of the previously performed antigen test of lower sensitivity.

Thirdly, there were frequent cases of testing results, the so-called false negative or false positive ones [7], initially implying a specific procedure which then turned out to be incorrect. Finally, the possibility of coronavirus infection was much more likely than in the case of a typical hospital-acquired infection, in which the particular risk was associated primarily with surgery or other invasive procedures, while in the case of SARS-CoV-2, the possibility of infection was associated with the usual contact with a patient [8], and therefore, it was particularly difficult to avoid, even with due diligence.

Specificity of evidence proceedings in cases for an infection

Pursuant to the provision of Article 6 of the Civil Code, the burden of proving the fact lies with the person who derives legal consequences from it. In the case of lawsuits related to infection with a biological agent, the jurisprudence assumes that it is sufficient for the affected person to substantiate the possibility of a medical error because his or her demonstration of the premises of the responsibility of a health care facility is an extremely difficult and sometimes even impossible task due to the properties of the biological processes involved. The existence of a causal link between a triggering event and damage, as a rule, cannot be certain, as far as human health is concerned, since the links occurring in the field of medicine cannot be reduced to a simple result of one phenomenon from another. Therefore, it would be unrealistic for a significant number of cases to require absolute certainty of the existence of a causal link [9].

An infection of a patient during his or her treatment at hospital may mean that the hospital has not provided the patient with a safe stay. Failure to comply with this obligation usually proves that there has been negligence in maintaining epidemiological standards and it is considered to be an organisational fault of a health care facility [10]. In the case of hospital-acquired infections, hospital's negligence may be assumed as a factual presumption which results in shifting the burden of proving that the infection did not occur as a result of failure to exercise due diligence

or the standards of current medical knowledge to the health care facility which is then required to demonstrate that the infection did not occur as a result of circumstances for which it is responsible [11]. Among the premises justifying the application of a presumption that a patient is infected, the following are mentioned: the fact that a patient was not infected with a pathogen at the time of hospital admission; other cases of infection are discovered at the same time and in the same hospital; negative sanitary and epidemiological assessments, failure to comply with the cleanliness requirements of medical equipment and personnel; a "hospital-acquired" or "community-acquired" type of bacteria causing a disease; no information about the fact that members of patient's family had previously suffered from a disease caused by such infection; the lapse of time from the stay at hospital to the discovery of symptoms of infection, corresponding to the incubation periods of the disease accepted in medicine. In practice, the above-mentioned circumstances are considered to increase the probability of infection of a patient in a specific hospital and, therefore, justify the presumption that the infection occurred in that facility [12].

The assessment of the organisation of the provision of health care services in the time of a pandemic must include both the organisational aspect of the functioning of a health care facility as well as due diligence in dealing with patients. As part of the prevention of the spread of infections, the first thing that can be indicated is the possibility of conducting laboratory screening tests, excluding SARS-CoV-2 infection at the stage of admission to hospital, which, however, is only possible with regard to elective medical procedures and allows for limiting the risk of hospitalisation of an infected person but not its complete elimination. Limiting the possibility of contacts between patients seems justified to the extent permitted by the current conditions of premises of a given health care facility, but the real possibility of ensuring epidemiological safety in this way before the outbreak of a pandemic existed only in infectious wards, where the standard of rooms provided for the arrangement of solitary confinements, which is not required or practised in other hospital wards and has been ad hoc introduced by the legislator in the requirements for the so-called temporary hospitals [13]. A standard of conduct is also using personal protective equipment and the applicable standards of conduct by medical personnel in the field of preventing and combating infections, resulting from the current suggestions and recommendations of relevant entities [8, 14–17]. All methods of preventing SARS-CoV-2 infection in hospitals do not guarantee that the effect would not occur in the form of an infection, but only reduce the probability of its occurrence, so the obligation to prevent this effect is a duty of careful action, not a result.

Conclusions

The assessment of whether a patient was infected with SARS-CoV-2 in connection with a hospital stay has been the fault of a health care facility, will require proving that this type of damage occurred as a result of failure to exercise due diligence or as a result of non-compliance with current medical knowledge. However, if organisational conditions of patient's stay, a diagnostic and treatment process and the conduct of medical personnel are in accordance with the current standards and are not negligent, the occurrence of infection will not result in hospital's liability, because it is not responsible for the result of non-infection but for due diligence in preventing it. Therefore, despite the observance of all procedures and due diligence, an undesirable event may occur, for which no one will bear responsibility. A physician is obliged to use available methods of prevention and treatment; therefore, his or her responsibility is derived from the means at his or her disposal, and this availability should be assessed in terms of medical, organisational, and economic availability. Due to the global nature of the pandemic, medical knowledge about coronavirus infection is global and is subject to dynamic changes, and the subsequent methods of preventing and combating SARS-CoV-2 are universal and widely available, which makes their use largely a global standard to be followed by health care facilities and medical personnel, and the compliance with it will ensure the possibility of exculpation, regardless of whether the prevention of infection is effective in each case.

Conflict of interest

None.

Funding

None.

Streszczenie

Trwająca od końca 2019 roku epidemia koronawirusa, która rychło zyskała rozmiary oraz status pandemii, na długo odmieniła rzeczywistość w ochronie zdrowia, nie tylko radykalnie testując wytrzymałość personelu medycznego oraz wydolność systemu, ale także wymuszając jego istotną, doraźną reorganizację. W okresie największej liczby zachorowań, zważywszy na ogniska zakażeń występujące w podmiotach leczniczych, decyzja o ograniczeniu dostępu do świadczeń zdrowotnych, zarówno w uzasadnionym ze względów zdrowotnych terminie (odroczenie przyjęć planowych), jak i w optymalnej medycznie formie (bezpośrednie badanie względem teleporady), mogła narazić pacjenta na ujemne skutki zdrowotne, będąc wszakże epidemiologicznie uzasadnioną. Wybór między ryzykiem epidemiologicznym a narażeniem pacjenta na konsekwencje zdrowotne z powodu nieudzielenia świadczenia w odpowiednim czasie lub formie obciążał kierujących podmiotami leczniczymi i personel medyczny. W świetle powyższego decyzja o udzieleniu świadczenia zdrowotnego w ramach hospitalizacji była nieodłącznie związana ze zwiększonym ryzykiem zakażenia koronawirusem zespołu ostrej niewydolności oddechowej (SARS-CoV-2) podczas pobytu w szpitalu, co uzasadnia prawną analizę możliwości kwalifikacji zakażenia SARS-CoV-2 jako zakażenia szpitalnego i związanych z tym konsekwencji prawnych.

Słowa kluczowe: zakażenie koronawirusem, zakażenie szpitalne, zapobieganie zakażeń, zwalczanie zakażeń

Folia Cardiologica 2022; 17, 1: 68–72

References

1. World Health Organization (WHO), BREAKING „We have therefore made the assessment that COVID19 can be characterized as a pandemic", @WHO, 11 March 2020 (retrieved: 2021-11-02).
2. Rzecznik Praw Pacjenta, Raport Rzecznika Praw Pacjenta, Problemy pacjentów w obliczu epidemii choroby COVID-19, Raport opracowany na podstawie sygnałów kierowanych do Rzecznika Praw Pacjenta za okres od stycznia do września 2020, Warsaw, October 2020, pp. 10–15. https://www.gov.pl/web/rpp/problemy-pacjentow-w-obliczu-epidemii-covid-19 (retrieved: 2021-11-08).
3. Act of 5 December 2008 on preventing and combating infection and infectious diseases in humans (Journal of Laws 2020, item 1845, as later amended).
4. Art. 2 sec. 20 and 21 of the Act of 5 December 2008 on preventing and combating infection and infectious diseases in humans (Journal of Laws 2020, item 1845, as later amended) states that a suspect of an infectious disease is a person with clinical symptoms or abnormalities in additional tests, which may indicate an infectious disease; a person suspected for infection is a person who has no symptoms of infection or an infectious disease, who has had contact with the source of the infection, and the nature of the infectious agent and the circumstances of contact justify the suspicion of infection.
5. Michalski A, Bielawska-Drózd A, Cieślik P, et al. Metody diagnostyki laboratoryjnej COVID-19. Wiedza Medyczna. 2020: 1–9, doi: 10.36553/wm.41.
6. https://www.mp.pl/covid19/zalecenia/265853,zalecenia-postepowania-w-zakazeniach-sars-cov-2-polskiego-towarzystwa-epidemiologow-i-lekarzy-chorob-zakaznych-26042021. https://www.mp.pl/covid19/zalecenia/265853,zalecenia-postepowania-w-zakazeniach-sars-cov-2-polskiego-towarzystwa-epidemiologow-i-lekarzy-chorob-zakaznych-26042021 (retrieved: 2021-11-10).
7. Recommendations of the NIPH-PZH in the field of SARS-CoV-2 molecular diagnostics updated on 31 May 2021. https://www.pzh.gov.pl/wp-content/uploads/2021/05/Rekomendacje-dot.-interpretacji-testow-rtPCR-z-31.05.2021.pdf (retrieved: 2021-11-10).
8. Rekomendowane rodzaje środków ochrony osobistej (PPE, ang. Personal Protective Equipment) dla personelu medycznego przy kontakcie z pacjentem z podejrzeniem lub rozpoznaniem zakażenia SARS-CoV-2. https://cm-uj.krakow.pl/cm/cm/uploads/2020/04/PPE-1.pdf (retrieved: 2021-11-10).
9. Judgement of the Supreme Court of 22 Feb. 2012, IV CSK 245/11, LEX no. 1164750; Judgement of the Court of Appeal in Poznań of 14 Nov. 2013, I ACa 819/13, LEX no. 1416234; Judgement of the Court of Appeal in Białystok of 29 Sept. 2014, I ACa 233/14, LEX no. 1526918; Judgement of the Court of Appeal in Katowice of 5 May 2016, I ACa 431/15, LEX no. 2061813.
10. Judgement of the Court of Appeal in Białystok of 12 Feb. 2021, I ACa 495/20, LEX no. 3154102.
11. Judgement of the Court of Appeal in Lublin of 19 June 2013, I ACa 727/12, LEX no. 1342295.
12. Judgement of the Court of Appeal in Szczecin of 13 June 2018, I ACa 190/16, LEX no 2688341.
13. Par. 3 sec. 1a and 1b of the Regulation and point VI of Annex 1 to the Regulation of the Minister of Health of 26 March 2019 on the requirements which should be met by the premises and equipment of a health care facility in terms of professional and sanitary conditions (Journal of Laws 2019, item 595, as later amended).
14. Ministerstwo Zdrowia, Wytyczne dla poszczególnych zakresów i rodzajów świadczeń. https://www.gov.pl/web/zdrowie/wytyczne-dla-poszczegolnych-zakresow-i-rodzajow-swiadczen (retrieved: 2021-11-06).
15. Ministerstwo Zdrowia, Zalecenia postępowania przy udzielaniu świadczeń stomatologicznych w sytuacji ogłoszonego na terenie Rzeczypospolitej Polskiej stanu epidemii w związku z zakażeniami wirusem SARS-CoV-2. https://www.gov.pl/web/zdrowie/zalecenia-postepowania-przy-udzielaniu-swiadczen-stomatologicznych-w-sytuacji-ogloszonego-na-terenie-rzeczypospolitej-polskiej-stanu-epidemii-w-zwiazku-z-zakazeniami-wirusem-sars-cov-2 (retrieved: 2021-11-06).

16. Zalecenia krajowego konsultanta w dziedzinie chorób zakaźnych z dnia 6.04.2020 dotyczące stosowania środków ochrony osobistej oraz sposób organizacji pomieszczeń, w których udzielana jest pomoc medyczna dla pacjentów z podejrzeniem COVID-19. https://cm-uj.krakow.pl/cm/cm/uploads/2020/04/Komunikat_KK-1.pdf (retrieved: 2021-11-06).

17. Wytyczne postępowania w oddziałach zabiegowych szpitali niejednoimiennych podczas pandemii COVID-19. https://cm-uj.krakow.pl/cm/cm/uploads/2020/04/WYTYCZNE-POST%C4%98POWANIA-W-ODDZIA%C5%81ACH-ZABIEGOWYCH-SZPITALI-NIEJEDNOIMIENNYCH.pdf (retrieved: 2021-11-06).