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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

The associations between atrial fibrillation and parameters of nutritional status assessment in the general hospital population — a cross-sectional analysis of medical documentation

Jacek Budzyński[1], Marzena Anaszewicz[2]

[1]Department of Vascular and Internal Diseases, Faculty of Health Sciences, Nicolaus Copernicus University in Toruń, Ludwik Rydygier Collegium Medicum, Bydgoszcz, Poland

[2]Clinic of Vascular and Internal Diseases, Jan Biziel University Hospital No. 2, Bydgoszcz, Poland

Abstract

Background: Atrial fibrillation (AF) and nutrition status abnormalities are two of the most significant epidemics in current health care.

Aim: The aim of this study was to determine the relationship between the prevalence and outcome of AF, and the parameters of nutritional status among consecutive, real-life patients hospitalised in a university hospital.

Methods: Analysis of the medical documentation of 4930 consecutive patients aged ≥ 18 years hospitalised for more than one day with diagnoses of cardiovascular disorders.

Results: Patients admitted with a diagnosis of AF (n = 512) compared to their counterparts without AF less frequently had an NRS-2002 score ≥ 3, normal range of body mass index (BMI), higher blood haemoglobin, and lower low density lipoprotein cholesterol (LDL-C) concentration. In logistic regression analysis, the risk of a hospitalisation due to AF was negatively related to BMI, NRS-2002 score, and the value of the difference between ideal and actual body mass. Urgent admission and having an NRS-2002 score ≥ 3 remained the only significant variables determining the risk of in-hospital death. Blood concentration of LDL-C and urgent admission were the only significant variables determining risk of 30-day rehospitalisation in the studied population.

Conclusions: Inpatients with AF had a lower prevalence of normal body mass. Patients with an AF diagnosis had different risk factors for in-hospital death and 30-day rehospitalisation than their counterparts with diagnosis of cardiovascular diseases but without AF; however, the parameters of nutritional status played an important role in both patient groups. The obesity and cholesterol paradoxes were also observed.

Key words: atrial fibrillation, nutritional status, prognosis

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INTRODUCTION

Atrial fibrillation (AF) is the most prevalent cardiac arrhythmia and a frequent cause of hospitalisation, as well as a common comorbidity in inpatients, which can affect not only patient's all-cause and cardiovascular (CV) mortality and morbidity, and quality of life, but also the risk of in-hospital complications, such as cardiac failure and embolic or haemorrhagic complications following antithrombotic drug use. Recently, there has been an increase in interest concerning the association between nutritional status and AF [1, 2]. The potential relationships between this cardiac arrhythmia and both over- and undernutrition have epidemiological and pathophysiological bases [2, 3]. Obesity or overweight, which, according to the POLSCREEN study, affects about 70% of the Polish population, acts as a risk factor for CV diseases (CVD) but is, on the other hand, in an obesity paradox mechanism, associated with reduced CV mortality among patients with AF [2, 4, 5]. Undernutrition, as a component of cardiac cachexia syndrome,

Address for correspondence:
Jacek Budzyński, MD, PhD, Department of Vascular and Internal Diseases, Faculty of Health Sciences, Ludwik Rydygier Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, ul. Ujejskiego 75, 85–168 Bydgoszcz, Poland, e-mail: budz@cps.pl

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may potentially be linked to the risk of AF; however, these relationships are less well documented, mainly due to the exclusion of underweight patients from analysis concerning associations between obesity and CVD [2, 6]. The proposed pathophysiological mechanisms linking overnutrition status with risk of AF are: (a) the effect of chronic inflammatory status associated with an imbalance in pro- and anti-inflammatory substances (adipokines, mainly adiponectin, and cytokines) produced by extra-cardiac, cardiac, and perivascular fatty tissue [6–10]; (b) left atrial enlargement [11]; (c) a decreased effect of atrial natriuretic factor, the blood concentration of which is inversely related to body mass index (BMI) [12]; (d) electromechanical dysfunction and adiponectin levels, both of which are positively correlated with BMI [11, 13]; (e) haemodynamic changes associated with obesity, and related increased pre- and afterload [13]; (f) autonomic nervous system imbalance and/or sympathetic overactivity in the course of coexisting coronary artery disease or heart failure [11, 14, 15]; (g) obstructive sleep apnoea [15]; (h) diabetes mellitus, insulin resistance [11]; (i) metabolic syndrome [16, 17]; and (j) gastroesophageal reflux disease [18]. Whereas, undernutrition may lead to cardiac arrhythmia via the following: (a) a decrease in fatty and fat-free body mass (sarcopaenia) due to the importance of muscle mass as a regulator of autonomic nervous system and metabolic balances; (b) an increase in pro-inflammatory cytokines, such as interleukin-6 and tumour necrosis factor-alpha, particularly in patients with cardiac cachexia; (c) a decrease in lipoprotein levels and their activity binding pro-inflammatory cytokines and endotoxins; (d) energetic deficit; (e) lipolysis acceleration; and (f) deficiency in electrolytes, antioxidants, vitamins, and proteinaceous components responsible for building the heart [19].

The aim of this study was to determine the importance of nutritional status in the risk of AF prevalence among a real-life population of adult patients hospitalised over the course of one year in a university hospital, and the relationships between nutritional status parameter values and the risk of the main outcomes among subjects with and without AF in a retrospective analysis of medical documentation.

METHODS

We performed an analysis of the medical documentation of all non-selected, consecutive patients admitted to the university hospital during the course of one year, i.e. between July 1, 2014 and June 30, 2015. During this period, 35,817 hospitalisations were carried out, of which 32,256 (90.05%) concerned patients older than 18 years and of which 20,205 (56.4% of all hospitalisations) lasted at least two days. The last inclusion criterion helped to exclude one-day hospitalisations, during which, in accordance with Polish regulations, routine nutrition status screening and assessment are not obligatory. Among the hospitalisations carried out, 4930 (24.4%) concerned patients treated non-invasively in internal medicine departments with CVD (any diagnosis code in the range I00-I99 according to ICD-10 classification), including 512 patients with AF or atrial flutter (identified as having an I48 code as a cause of hospitalisation on discharge). The main analysis concerned this population.

The following parameters were measured: diagnosis of I48 on patient's discharge, age, aged above 65 years, gender, hospitalisation mode (whether urgent or scheduled), in-hospital death, non-elective readmission, Nutritional Risk Screening (NRS) 2002 questionnaire score, the number of patients with an NRS-2002 score ≥ 3 (a score of at least three points in the questionnaire indicates a risk of malnutrition), body mass, height, BMI, BMI range according to the World Health Organisation (WHO) categories (underweight: BMI < 18.5 kg/m^2; normal weight: 18.5 ≤ BMI < 25 kg/m^2; overweight: 25 ≤ BMI < 30 kg/m^2; and obese: BMI ≥ 30 kg/m^2), blood concentration of low-density lipoprotein cholesterol (LDL-C), glucose, albumin, C-reactive protein (CRP), and absolute lymphocyte count. All the biochemical parameters included in the analysis were the first determinations taken during respective hospitalisations. The following secondary parameters were also calculated:

- an "ideal weight" was calculated according to the Lorentz formula: for female patients, ideal weight = [height (cm) – 100] – {[height (cm) – 150]/2}; and for male patients, ideal weight = [height (cm) – 100] – {[height (cm) – 150]/4} [20];
- "body mass deficit/excess" was calculated according to the following formula: actual body mass — ideal weight calculated according to the Lorentz formula; negative value shows on body weight deficit and positive value on excess of body mass;
- blood CRP/albumin ratio;
- median values for albumin concentration, CRP/albumin ratio, and lymphocyte count for split analysis and odds ratio (OR) calculation.

Measured outcomes

The following outcomes were measured: diagnosis of AF, values of clinical, anthropometric, and biochemical parameters in AF and non-AF groups, in-hospital all-cause mortality, and non-elective readmission in the 30-day period following discharge.

Bioethics

The investigation was conducted in compliance with the Declaration of Helsinki for medical research.

Statistical analysis

Statistical analysis was conducted using licensed versions of statistical software STATISTICA (a data analysis software system), StatSoft, Inc. (2011), version 12. The normal distribution of the study variables was checked using the

Table 1. Demographic and biochemical characteristics of the patients with cardiovascular disorders analysed divided in relation to the cause of hospitalisation being due to atrial fibrillation (AF) or other (n = 4930)

Feature	Patients with AF (n = 512)	Patients without AF (n = 4418)	P
Age [years]	69.4 ± 11.7	67.2 ± 13.2	< 0.001
Age > 65 years	361 (70.5%)	2650 (60.0%)	< 0.001
Male gender	246 (48.1%)	2355 (53.3%)	0.02
Urgent admission	459 (89.7%)	3189 (72.1%)	< 0.001
Length of hospital stay [days]	3.7 ± 4.2	6.1 ± 6.8	< 0.001
In-hospital death	5 (1.0%)	195 (4.4%)	< 0.001
Number of non-scheduled rehospitalisations 14 days after discharge	20 (4.0%)	97 (2.2%)	0.012
Number of non-scheduled rehospitalisations 30 days after discharge	47 (9.5%)	244 (5.6%)	0.001
Number of rehospitalisations during the period analysed	166 (32.8%)	999 (23.2%)	< 0.001
NRS-2002 score (n = 505; 4345)	0.7 ± 0.9	0.8 ± 1.0	0.003
NRS-2002 ≥ 3	18 (3.6%)	377 (8.7%)	< 0.001
Height [cm] (n = 394; 3258)	167.8 ± 10.1	167.3 ± 9.3	0.27
Body mass [kg] (n = 411; 3310)	81.7 ± 18.8	79.2 ± 17.4	0.007
BMI [kg/m^2] (n = 394; 3229)	28.9 ± 5.5	28.3 ± 5.5	0.033
BMI range [kg/m^2]:			
< 18.5	6 (1.5%)	52 (1.6%)	0.86
18.5–24.99	90 (22.8%)	899 (27.8%)	0.016
25–29.99	154 (39.1%)	1168 (26.4%)	< 0.001
> 30	144 (36.5%)	1110 (25.1%)	< 0.001
Presence of body mass deficit	68 (17.3%)	628 (19.5%)	0.29
Haemoglobin [G/L] (n = 484; 4023)	13.8 ± 1.8	13.4 ± 1.9	< 0.001
LDL-C [mg/dL] (n = 249; 2890)	108.0 ± 37.3	114.9 ± 40.4	0.01
Triglycerides [mg/dL] (n = 238; 2139)	126.4 ± 60.6	138.0 ± 97.2	0.07
Blood glucose [mg/dL] (n = 374; 3019)	133.3 ± 60.0	131.1 ± 59.5	0.51
CRP [mg/dL] (n = 285; 2751)	18.2 ± 38.1	21.0 ± 44.2	0.30
TSH [mU/L] (n = 410; 2126)	3.2 ± 9.1	3.2 ± 11.1	0.98
Blood lymphocyte count [G/L] (n = 24; 389)	1.3 ± 0.8	2.6 ± 9.1	0.48
Blood albumin [G/L] (n = 27; 529)	3.2 ± 0.5	3.5 ± 4.3	0.71
CRP/albumin ratio (n = 25; 499)	15.4 ± 21.0	15.0 ± 27.7	0.95

Not all data were available for all calculations; therefore, for every parameter the number of subjects in the subgroups (AF; without AF) is given in brackets. NRS — Nutritional Risk Screening; BMI — body mass index; body mass deficit — presence of a negative value for the difference between actual body mass and ideal body mass calculated according to the Lorentz formula; LDL-C — low-density lipoprotein cholesterol; CRP — C-reactive protein; TSH — thyrotropin-stimulating hormone

Shapiro-Wilk test. The results were mainly presented as the mean ± standard deviation, n, %, or an OR. The statistical significance of differences between groups was verified using the Student's t-test and χ^2 test. Logistic regression using Rosenbrock and the quasi-Newton method was applied to check the relationships between the measured outcomes and the variables analysed. The statistical significance level was set at a p-value < 0.05. The OR was defined as the odds that an outcome would occur with the association of some value of an estimated variable (a clinical or biochemical parameter), compared to the odds of the outcome occurring in the absence of that association, and was calculated according to the following formula: the product of the number of subjects with the measured outcome and the presence of the variables analysed (exposed cases) and the number of subjects without the measured outcome and analysed variables (unexposed non-cases) divided by the product of the numbers of exposed non-cases and unexposed cases.

RESULTS

During the one-year period of analysis in our hospital, 512 of 4930 (10.39%) hospitalisations in internal medicine departments due to various CV disorders concerned patients with a diagnosis of AF on discharge (Table 1). In comparison to individuals without an AF diagnosis, patients with AF were significantly older, (more likely to be above 65 years old) female, significantly more frequently admitted urgently, readmitted during the one-year period analysed and during the 30 days after discharge, and had shorter hospitalisation duration and lower risk of in-hospital death (Table 1). In the group of inpatients studied, the values for the nutritional status parameters were obtained for different segments of the population of hospitalised patients (Table 1, first column). Despite this, we obtained a statistically significant difference between patients with a diagnosis of AF and individuals admitted due to other reasons. The first group less frequently had an NRS-2002 score ≥ 3 and a normal BMI range, had a greater average body mass and BMI value, higher blood haemoglobin concentration, as well as lower NRS-2002 score and LDL-C blood concentration (Table 1).

In the next part of the analysis, we tried to compare the strength of the associations between the respective clinical parameters and the determined measured outcomes for patients discharged with diagnosis of CV disorders on discharge (Table 2). In patients with AF compared to those patients without AF an NRS-2002 score ≥ 3 (OR 48.5) and a deficit of body mass (OR 11.9) were the only significant factors and also had the strongest effect on increasing the risk of in-hospital death (Table 2). None of the variables were associated with a significant risk of 30-day readmission among patients with AF. However, in patients discharged with a CV diagnosis other than AF, we found a number of significant nutritional status indices associated with the measured outcomes, including reduced risk of in-hospital death and 30-day non-scheduled rehospitalisation in patients with an LDL-C blood concentration ≥ 100 mg/dL (Table 2).

In multivariate analysis based on a logistic regression method among patients with diagnosis of CV disorders, the risk of a diagnosis of AF on discharge was related to the following three variables determining a patient's nutritional status: BMI, NRS-2002 score, and the value of the difference between ideal and actual body mass. It was, in addition, weakly increased with patients' age (Table 3A). However, risk of in-hospital death (Table 3B) and readmission within 30 days of discharge (Table 3C) had no statistically significant association with a diagnosis of AF, but did have a significant association with NRS-2002 score and BMI. Moreover, an increase in BMI of one unit increased risk of in-hospital death by 7% (Table 3B) and decreased the risk of 30-day readmission by 2% (Table 3C), although in both cases urgent admission had the strongest association.

To check the importance of the "cholesterol paradox" [21, 22], we added actual LDL blood concentration to the above-mentioned models (Tables 3A–D). The inclusion of this variable had no effect on the influence of nutritional status parameters on the risk of AF (Table 3A) and in-hospital death (Table 3B). However, in regard to the risk of 30-day readmission adding actual LDL-C blood concentration to the logistic regression model (Table 3C), the variables of age, BMI, and NRS-2002 score become non-significant, and the only significant variables determining risk of rehospitalisation remaining were LDL (OR 0.99; 95% confidence interval [CI] 0.98–0.995) and urgent admission (OR 5.98; 95% CI 2.15–16.66) (Table 3D). The performance of separate multifactorial analysis of the parameters analysed and outcomes measured was impossible to conduct solely for AF patients due to the small patient sample size and uncomplete data.

DISCUSSION

Our study, based on data from one year of medical documentation at a university hospital, is the first in Poland to assess the relationship between AF and nutritional status parameter values. We found that, compared to their counterparts, inpatients with AF had a lower prevalence of normal body mass, as well as a lower risk of malnutrition expressed by an NRS-2002 score ≥ 3 (Table 1). Nevertheless, among inpatients with AF, an NRS-2002 score ≥ 3 was one of two significant parameters and also the strongest risk factor for in-hospital death (Table 2). Whereas, in the remaining patients, without a diagnosis of AF, more of the nutritional status parameters predicted the occurrence of the measured outcomes (Table 2), although values of these parameters did not differ between patients with and without an AF diagnosis (Table 1). In contrast with the results of the univariate analysis, multifactorial analysis using a logistic regression method found that BMI and NRS-2002 score were negatively related with a diagnosis of AF (Table 3A). On the other hand, an NRS-2002 score was the risk factor for in-hospital death (Table 3B) and a significant risk factor for 30-day readmission (Table 3C). However, when an actual LDL-C blood concentration was included in the regression model (Table 3D), the statistical significance of BMI and NRS-2002 score as risk factors for 30-day rehospitalisation disappeared and LDL-C blood concentration was significant, weak, and negative, suggesting the presence of the "cholesterol paradox" in the hospitalised patients [21, 22].

To the best of our knowledge, our study is the first work showing relationships between AF and this number of parameters of nutritional screening and assessment in hospitalised patients. For this reason, it is difficult to compare our results with the observations of other authors. However, our univariate analysis corroborates the positive relationship between AF occurrence and BMI in all the patients studied and in individuals with CV disorders (Table 1) shown by other authors [1, 2], as well as between BMI and NRS-2002 score and risk of in-hospital death (Table 3B) [23–25]. Whereas, the multivariate analysis found negative associations between both BMI and NRS-2002 score and AF occurrence (Table 3A) and also the risk of readmission (Table 3C), which was consistent with the obesity paradox paradigm [2, 4–6]. In the ARIC study,

Table 2. Comparison of the prevalence and risk of the outcomes measured in relation to nutritional status parameters analysed for patients with cardiovascular diseases (n = 4930) with atrial fibrillation (AF) and without AF

Variable	In-hospital all-cause mortality (n = 200)		30-day readmission (n = 291)	
	Patients with AF (n = 5/512)	Patients without AF (n = 195/4418)	Patients with AF (n = 47/512)	Patients without AF (n = 244/4418)
Urgent admission	1.00% vs. 0% P = 0.86 OR 1.3 0.1–23.7	5.97% vs. 0.41% P < 0.001 OR 15.6 6.4–38.0	9.46% vs. 9.43% P = 0.98 OR 1.00 0.38–2.66	7.42% vs. 0.97% P < 0.0001 OR 8.15 4.55–14.62
Age > 65 years	1.11% vs. 0.66% P = 0.46 OR 1.7 0.2–15.2	5.66% vs. 2.55% P < 0.001 OR 2.30 1.6–2.3	9.40% vs. 9.59% P = 0.94 OR 0.98 0.51–1.89	6.35% vs. 4.47% P < 0.001 OR 1.53 1.36–1.72
Male vs. female gender	0.81% vs. 1.13% P = 0.72 OR 0.72 0.12–4.33	4.25% vs. 4.6% P = 0.56 OR 0.92 0.69–1.22	8.47% vs. 10.34% P = 0.48 OR 0.80 0.44–1.47	6.02% vs. 5.12% P = 0.19 OR 1.19 0.91–1.54
NRS-2002 ≥ 3	16.67% vs 0.41% P < 0.0001 OR 48.5 7.5–312.0	23.87% vs. 2.55% P < 0.001 OR 12.00 8.8–16.3	11.11% vs. 9.51% P = 0.82 OR 1.19 0.26–5.33	6.97% vs. 5.44% P =0.22 OR 1.31 0.85–1.99
Deficit of body mass	3.13% vs 0.28% P = 0.31 OR 11.9 0.71–190.7	2.39% vs. 1.52% P = 0.24 OR 1.58 0.74–3.39	9.68% vs. 9.17% P = 0.92 OR 1.06 0.31–3.68	6.61% vs. 4.92% P = 0.18 OR 1.37 0.86–2.17
BMI ≥ 30 kg/m^2	0.69% vs. 0.40% P = 0.70 OR 1.74 0.11–28.0	1.80% vs. 1.51% P = 0.53 OR 1.19 0.68–2.01	10.95% vs 8.23% P = 0.38 OR 1.37 0.65–2.64	4.54% vs. 5.40% P = 0.29 OR 0.83 0.59–1.17
LDL-C ≥ 100 mg/dL	0.78% vs. 0.83% P = 0.97 OR 0.94 0.06–15.3	2.69% vs. 3.38% P = 0.68 OR 0.79 0.51–1.22	2.34% vs. 6.19% P = 0.13 OR 0.36 0.10–1.44	1.89% vs. 4.12% P < 0.0001 OR 0.45 0.29–0.71
Glucose ≥ 200 mg/dL	0% vs 1.15% P = 0.81 OR 1.44 0.07–27.6	13.59% vs. 4.76% P < 0.001 OR 3.15 2.15–4.61	12.00% vs 6.65% P = 0.72 OR 1.25 0.36–4.40	8.10% vs. 5.48% P = 0.07 OR 1.52 0.96–2.40
Albumin ≥ 3.35 G/L	0% vs 21.4% P = 0.06 OR 0.05 0.002–1.1	14.06% vs. 34.43% P < 0.001 OR 0.31 0.20–0.47	7.69% vs. 0.0% P = 0.45 OR 3.48 0.13–93.3	5.14% vs. 8.71% P = 0.11 OR 0.56 0.28–1.14
CRP/albumin ratio ≥ 3.95	0% vs. 31.82% P = 0.43 OR 0.29 0.01–6.4	35.66% vs.16.47% P < 0.001 OR 2.81 1.84–4.29	0% vs. 9.1% P = 0.40 OR 0.24 0.01–6.50	8.82% vs. 5.62% P = 0.19 OR 1.60 0.79–3.22
Lymphocyte count ≥ 1.55 G/L	0% vs. 18.8% P = 0.91 OR 0.82 0.03–20.3	7.07% vs. 22.51% P < 0.001 OR 0.26 0.14–0.50	0% vs. 10.53% P = 0.36 OR 1.00 0.04–26.69	3.59% vs. 7.49% P = 0.023 OR 0.52 0.40–0.66

Commentary: The above table represents the split analysis according to median or arbitrarily established range values. Data are presented as a percentage of the exposed cases and odds ratio for the probability of the measured outcome occurrence in hospitalisations/patients having a value of an analysed nutritional status parameter greater than or equal to the median value, or having their arbitrary established value. Deficit of body mass was defined as a negative difference between actual and ideal body mass. OR — odds ratio; NRS — Nutritional Risk Screening; BMI — body mass index; LDL-C — low-density lipoprotein cholesterol; CRP — C-reactive protein

Table 3A. Factors determining the risk of hospitalisation due to atrial fibrillation in patients with cardiovascular disorders in the logistic regression model; $Chi^2 = 40.626$; $p < 0.0001$ (n = 3139)

Parameter	Constant	BMI	Age	NRS-2002 score	Deficit/excess of body mass	LDL-C
Estimation	–0.28	–0.21	0.042	–0.44	0.08	–0.003
Standard error	1.65	0.07	0.01	0.12	0.03	0.002
t(3 130)	–0.17	–2.78	4.68	–3.60	3.22	–1.42
P	0.86	0.01	< 0.0001	0.0003	0.001	0.15
OR ± 95% CI for one unit	0.75 ± 0.03–19.28	0.81 ± 0.70–0.94	1.04 ± 1.02–1.06	0.64 ± 0.51–0.82	1.09 ± 1.03–1.14	0.99 ± 0.99–1.00

Not all data were available for all calculations; therefore, the number of subjects taken into analysis is given in brackets in the title of the table. BMI — body mass index; NRS — Nutritional Risk Screening; weight difference — difference between current body mass and ideal body mass calculated according to the Lorentz formula; LDL-C — low-density lipoprotein cholesterol; OR — odds ratio; CI — confidence interval

Table 3B. Factors determining the risk of in-hospital all-cause mortality in patients hospitalised due to cardiovascular disorders in the logistic regression model; Chi^2 (6) = 53.74; $p < 0.0001$ (n = 3139)

Parameter	Constant	Age	AF	NRS-2002 score	BMI	Urgent hospitalisation	LDL-C
Estimation	–9.29	0.006	–0.82	1.01	0.066	1.95	–0.004
Standard error	2.17	0.02	1.04	0.17	0.032	1.03	0.005
t(3 130)	–4.28	0.32	–0.79	5.80	2.09	1.90	–0.84
P	< 0.0001	0.75	0.43	< 0.0001	0.037	0.058	0.40
OR ± 95% CI for one unit	0.0001 ± 0.0001–0.007	1.01 ± 0.97–1.05	0.44 ± 0.06–3.36	2.74 ± 1.95–3.85	1.07 ± 1.01–1.14	7.04 ± 0.94–53.03	0.99 ± 0.99–1.01

Not all data were available for all calculations; therefore, the number of subjects taken into analysis is given in brackets in the title of table. AF — atrial fibrillation; NRS — Nutritional Risk Screening; BMI — body mass index; LDL-C — low-density lipoprotein cholesterol; OR — odds ratio; CI — confidence interval

Table 3C. Factors determining the risk of 30-day rehospitalisation for all consecutive patients in the logistic regression model; Chi^2 (5) = 97.44; $p < 0.00001$ (n = 3554)

Parameter	Constant	Age	AF	NRS-2002 score	BMI	Urgent hospitalisation
Estimation	–5.76	0.027	0.35	–0.80	–0.11	1.81
Standard error	0.68	0.008	0.20	0.099	0.014	0.28
t(3 548)	–8.43	3.50	1.76	–0.79	–0.93	6.40
P	< 0.001	0.001	0.08	0.043	0.035	< 0.0001
OR ± 95% CI for one unit	0.003 ± 0.001–0.01	1.03 ± 1.01–1.04	1.42 ± 0.96–2.10	0.92 ± 0.76–0.99	0.99 ± 0.96–0.995	6.10 ± 3.51–10.61

Not all data were available for all calculations; therefore, the number of subjects taken into analysis is given in brackets in the title of table. AF — atrial fibrillation; NRS — Nutritional Risk Screening; BMI — body mass index; OR — odds ratio; CI — confidence interval

no significant associations were found between BMI and CV outcomes in patients with AF [1].

In our study, we also found another paradox linking nutritional status and mortality: the "cholesterol paradox" (Tables 2, 3D). This paradox means that patients with a greater blood cholesterol concentration have a better prognosis than subjects with a low plasma lipid level [21, 22], which was found in relation to the risk of AF occurrence (Table 1), all-cause mortality, and 30-day readmission for patients without AF (Tables 2, 3D). However, in the context of the proven favourable effect of the most popular lipid-lowering drugs, statins, on CV and all-cause mortality [21], the poor prognosis linked with low

Table 3D. Factors determining the risk of 30-day rehospitalisation in all consecutive in the logistic regression model with an added variable of LDL to the model presented in Table 3C; Chi^2 (6) = 37.89; p < 0.00001 (n = 3139)

Parameter	Constant	Age	AF	NRS-2002 score	BMI	Urgent hospitalisation	LDL-C
Estimation	–5.64	0.01	0.15	–0.11	–0.002	2.15	–0.99
Standard error	1.02	0.01	0.39	0.49	0.02	0.52	0.24
t(3 130)	–5.52	1.12	0.40	-0.22	–0.11	4.15	–4.07
P	< 0.0001	0.26	0.69	0.82	0.91	< 0.0001	< 0.0001
OR ± 95% CI for one unit	0.01 ± 0.001–0.16	1.02 ± 0.99–1.05	1.25 ± 0.58–2.71	0.88 ± 0.63–1.24	0.99 ± 0.94–1.04	5.98 ± 2.15–16.66	0.99 ± 0.98–0.995

Not all data were available for all calculations; therefore, the number of subjects taken into analysis is given in brackets in the title of table. AF — atrial fibrillation; NRS — Nutritional Risk Screening; BMI — body mass index; LDL-C — low-density lipoprotein cholesterol; OR — odds ratio; CI — confidence interval

plasma cholesterol concentration should be interpreted as a result of poor health condition and/or malnutrition. Such an assumption is based on our own results, which showed that NRS-2002 score and body mass deficit, expressed as a negative difference between actual and ideal body mass, were the only risk factors for in-hospital death among patients with AF (Table 2).

Despite having obtained a number of statistically significant differences between the groups analysed, we, as most authors, could not avoid some methodological shortcomings that could have influenced the strength of the deductions based on our results. The main limitations were selection bias connected with the direct comparison of patients admitted with a diagnosis of AF on discharge with the remaining, heterogenic patients without AF, hospitalised in internal medicine departments and treated non-invasively due to CV disorders, but with various comorbidities. Secondly, we based the diagnosis of AF (I48 according to ICD-10 classification) on data from discharge reports, not on the basis of repeated electrocardiogram analysis of all hospitalised patients. Therefore, we cannot give data concerning past medical history of AF and type of arrhythmia (paroxysmal, persistent, or permanent), and differentiate patients admitted due to atrial flutter and AF. Thirdly, we performed a retrospective study based on only single-centre documentation analysis with a lack of follow-up after discharge. Therefore, we were only able to include readmissions to our hospital; any patients who were hospitalised in other centres were omitted from the analysis. Fourthly, we focused only on the relationships between nutritional status parameters and measured outcomes, but these might have been influenced by a number of factors other than nutritional status alone, e.g. disease severity and comorbidities, which may also have biased the results obtained. However, only such analysis made it possible to assess the importance of nutritional status to the outcomes in a real-life population of patients with AF. Moreover, adjusting the results obtained for all potential biases was impossible, and this potential bias is a shortcoming in many investigations on the usefulness of nutritional status assessment tools [24, 25]. However, the NRS-2002 questionnaire was a strong risk factor for in-hospital death among patients with AF and without (Table 2) and all included patients diagnosed with CV disorders (Table 3B) and, at the same time, a factor protecting against AF occurrence (Table 3A), which not only expressed the patients' nutritional status, but also their main disease severity. Fifthly, not all of the analysed parameters, especially biochemical, were assessed in all of the patients studied, which shows that the clinical screening of nutritional status among inpatients is still unsatisfactory in Poland (thyrotropin-stimulating hormone determination was more prevalent than BMI; Table 1). Moreover, other anthropometric parameters, such as neck, waist, and hip circumference, skin fold thickness, and body composition, were not available. Also, we cannot provide data concerning patient treatment and risk factors for CVD and AF, such as prevalence of smoking, diabetes, hypertension, and alcohol consumption. However, in our study, this resulted in a failure to achieve statistical significance in the majority of biochemical nutritional status parameters among AF patients (Table 2) and made it impossible to perform separate multivariate analysis using the multiple regression method in this subgroup. On the other hand, a large sample size might have made it impossible to offer a verdict on the ability of the variables analysed (Table 2) to predict the measured outcomes [24].

CONCLUSIONS

Compared with individuals hospitalised due to various CV disorders but without a diagnosis of AF, inpatients with AF had a lower risk of malnutrition, expressed by an NRS-2002 score ≥ 3 and a lower prevalence of normal body mass. Patients discharged with a diagnosis of AF had different risk factors for in-hospital death and 30-day rehospitalisation to their counterparts, although the parameters of nutritional status played an important role in both patient groups. The obesity paradox and cholesterol paradox, expressed by a lower risk of AF diagnosis on discharge and readmission, as well as better prognoses among patients without AF and with a higher LDL-C level, were also found. However, the cholesterol paradox could be explained by the effect of the severity of the main disease and comorbidities and not as an indication, for example, for stopping treatment with statins, which have proven favourable effects. These observations show the necessity for nutritional status evaluation in all hospitalised patients, including individuals with AF. Such patient management might have an influence on the better recognition of patients' prognoses, the motivation for weight control, and qualification criteria for more aggressive treatment.

Conflict of interest: *none declared*

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Związek między migotaniem przedsionków a wskaźnikami stanu odżywienia u pacjentów hospitalizowanych — przekrojowa analiza dokumentacji medycznej

Jacek Budzyński[1], Marzena Anaszewicz[2]

[1]Katedra Chorób Naczyń i Chorób Wewnętrznych, Wydział Nauk o Zdrowiu, Uniwersytet Mikołaja Kopernika w Toruniu, *Collegium Medicum* im. Ludwika Rydygiera, Bydgoszcz

[2]Klinika Chorób Naczyń i Chorób Wewnętrznych, Szpital Uniwersytecki nr 2 im. dr. Jana Biziela, Bydgoszcz

Streszczenie

Wstęp: Migotanie przedsionków (AF) i nieprawidłowości stanu odżywienia są obecnie jednymi z dwóch najczęściej występujących problemów współczesnej opieki zdrowotnej. Związek między tymi stanami jest uwarunkowany wieloma czynnikami patofizjologicznymi, m.in. takimi jak: prozapalny efekt adipokin i cytokin produkowanych przez tkankę tłuszczową trzewną i okołosercową, zmiany aktywności autonomicznego układu nerwowego, zespół bezdechu sennego, zespół metaboliczny, refluks żołądkowo-przełykowy, powiększenie przedsionka, przerost mięśnia sercowego i zaburzenia przewodzenia wewnątrzsercowego.

Cel: Celem pracy była ocena związku między wartościami wskaźników stanu odżywienia pacjentów i zgonem wewnątrzszpitalnym a koniecznością rehospitalizacji w ciągu 30 dni u osób hospitalizowanych z powodu AF w porównaniu ze wszystkimi kolejnymi pacjentami hospitalizowanymi z powodu choroby sercowo-naczyniowej w jednym szpitalu uniwersyteckim w ciągu jednego roku.

Metody: Przeprowadzono analizę dokumentacji medycznej 4930 kolejnych pacjentów w wieku ≥ 18 lat hospitalizowanych w jednym szpitalu, w ciągu jednego roku kalendarzowego, na oddziałach internistycznych dłużej niż jeden dzień i wypisanych z rozpoznaniem sercowo-naczyniowej jednostki chorobowej jako schorzenia zasadniczego (kody I00-I99 w klasyfikacji ICD-10). Pacjentów z AF (n = 512) identyfikowano jako osoby z rozpoznaniem wypisowym I48 wg ICD-10. Grupę kontrolną stanowili pozostali chorzy (n = 4418), u których nie rozpoznano AF przy wypisaniu ze szpitala. Analizowano następujące wskaźniki stanu odżywienia: punktację w skali NRS-2002, wskaźnik masy ciała (BMI), obecność deficytu masy ciała względem wagi idealnej wyliczonej ze wzoru Lorentza, stężenie hemoglobiny, cholesterolu frakcji LDL (LDL-C), triglicerydów, glukozy, albumin, iloraz stężeń białka C-reaktywnego (CRP) i albumin oraz bezwzględną liczbę limfocytów krwi. Za mierzone punkty końcowe analizy przyjęto zgon wewnątrzszpitalny z jakiegokolwiek powodu i rehospitalizację w ciągu 30 dni.

Wyniki: Pacjenci przyjęci z powodu AF, w porównaniu z osobami z chorobami sercowo-naczyniowymi, ale bez AF, byli starsi, mieli niższą średnią punktację w kwestionariuszu oceny ryzyka związanego z niedożywieniem (NRS-2002), rzadziej uzyskiwali punktację NRS-2002 ≥ 3 (przyjęty powszechnie punkt odcięcia dla zwiększonego ryzyka związanego z niedożywieniem), charakteryzowali się większą średnią masą ciała i wartością BMI, istotnie rzadziej mieścili się w przedziale prawidłowych wartości BMI (18,5–25 kg/m^2; 22,8% vs. 27,8%; p = 0,016) oraz mieli wyższe stężenie hemoglobiny przy przyjęciu i niższe stężenie LDL-C. Punktacja NRS-2002 ≥ 3 oraz niedobór masy ciała były jedynymi czynnikami predykcyjnymi zgonu u pacjentów z AF. U osób bez AF, oprócz tych parametrów kilka innych uzyskało znamienność statystyczną względem oceny ryzyka zgonu wewnątrzszpitalnego i rehospitalizacji w ciągu 30 dni. W analizie metodą regresji logistycznej ryzyko przyjęcia do szpitala z powodu AF było znamiennie statystycznie powiązane negatywnie z wartością BMI, punktacją w kwestionariuszu NRS-2002 oraz bezwzględną różnicą między idealną i aktualną masą ciała. Przyjęcie w trybie pilnym (tylko u pacjentów bez AF) oraz uzyskanie przynajmniej 3 punktów w skali NRS-2002 były jedynymi niezależnymi czynnikami ryzyka zgonu wewnątrzszpitalnego. Natomiast stężenie LDL-C (iloraz szans [OR] 0,99 ± 95% przedział ufności [CI] 0,98–0,995) i hospitalizacja w trybie pilnym (OR 5,98 ± 95% CI 2,15–16,66) były jedynymi znamiennymi czynnikami ryzyka rehospitalizacji w ciągu 30 dni w badanej grupie.

Wnioski: Pacjenci z AF, w porównaniu z pozostałymi hospitalizowanymi z powodu chorób sercowo-naczyniowych, ale bez AF, rzadziej prezentowali prawidłowy zakres BMI. Pacjenci z AF charakteryzowali się innymi czynnikami ryzyka zgonu wewnątrzszpitalnego i rehospitalizacji w ciągu 30 dni niż osoby przyjęte z innego powodu, w obu grupach jednak parametry stanu odżywienia odgrywały istotną rolę. Obserwowano także „paradoks otyłości" polegający na mniejszym ryzyku hospitalizacji z powodu AF i rehospitalizacji w ciągu 30 dni po wypisaniu z jakiegokolwiek powodu oraz „paradoks cholesterolowy" polegający na mniejszym ryzyku rehospitalizacji 30-dniowej u pacjentów z wyższym stężeniem LDL-C.

Słowa kluczowe: migotanie przedsionków, stan odżywienia, parametry biochemiczne, rokowanie

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