High Blood Press Cardiovasc Prev
DOI 10.1007/s40292-017-0227-y

ORIGINAL ARTICLE

Impact of Clinical Factors on the Achievement of Target Blood Pressure in Hypertensive Patients from Ivanovo Region of Russia: Data of 2015

A. R. Kiselev[1] · O. M. Posnenkova[1] · O. A. Belova[2] · S. V. Romanchuk[3] · Y. V. Popova[1] · M. D. Prokhorov[4] · V. I. Gridnev[1]

Received: 4 July 2017 / Accepted: 14 August 2017

Abstract

Introduction In Russia, blood pressure (BP) control is below the optimal. The little is known about regional features and barriers to adequate BP control in Russian primary care.

Aim To evaluate the impact of clinical factors on achieving the target BP in hypertensive patients in one region of Russia.

Methods Retrospective medical data of 2015 on 11,129 patients (31.4% male) with hypertension (Htn) from Ivanovo region of Russia were examined. Achievement of target BP was assessed in all patients. We study association between BP control and clinical factors.

Results 45.9% of studied patients with Htn had controlled BP. The frequency of achieving the target BP in subsets of hypertensive patients was 37.8% in patients with diabetes, 39.5% in patients with coronary artery disease, and 29.9% in patients with chronic heart failure. The main clinical factors associated with achieving the target BP in studied hypertensive patients were the advice on alcohol consumption, advice on smoking cessation, and advice on weight reduction. Therapy with main antihypertensive drugs (in particular, beta-blockers and thiazide diuretics) were also factors of optimal BP control in these patients. Comorbidities (chronic heart failure and cardiovascular diseases requiring the prescription of aspirin and statins) and family history of coronary artery disease were associated with inadequate BP control. A negative effect of some antihypertensive drugs (potassium sparing diuretics, ARBs, ACE-Is, and dihydropyridine CCBs) on BP control that was found out in our study requires further investigation. Other studied factors had no influence on BP control in patients with Htn from Ivanovo region.

Conclusion We identified regional factors of BP control in hypertensive patients from Ivanovo region of Russia. It is shown that individual medical education (in particular, medical advices) is the most important factor of optimal BP control. The intervention with antihypertensive therapy (beta-blockers and thiazide diuretics) facilitates the achievement of target BP. Comorbidity and age reduce the frequency of achieving the target BP.

Keywords Hypertension · Target blood pressure · Clinical factors · Registry

This article is part of the topical collection on Epidemiology of Hypertension.

✉ A. R. Kiselev
kiselev@cardio-it.ru

[1] Research Institute of Cardiology, Saratov State Medical University n.a. V.I. Razumovsky, 112, Bolshaya Kazachya str., Saratov 410012, Russia

[2] Ivanovo Regional Cardiology Dispensary, Ivanovo, Russia

[3] Healthcare Department of Ivanovo Region, Ivanovo, Russia

[4] Saratov Branch of the Institute of Radio Engineering and Electronics of Russian Academy of Sciences, Moscow, Russia

1 Introduction

Improving the quality of healthcare in patients with hypertension (Htn) is a priority goal of modern cardiology. In Russia, the prevalence of Htn in 21 century is about 40% among the adult population [1, 2] that is higher than in other countries. For comparison, about one-third of USA [3, 4], France [5], or Australian [6] adult population has Htn. In Canada, the prevalence of Htn is 22% [7]. Htn has been diagnosed in 25.9% of adult outpatients in Italy [8]. Prevalence of Htn is associated with different social,

Published online: 30 August 2017

occupational, genetic, physical or ecological factors [9–15].

It is known that achievement of target blood pressure (BP) (<140/90 mmHg) decreases the risk of cardiovascular events [14]. Nevertheless, most hypertensive patients have inadequate BP control [14]. Poor control of BP can be associated with many factors, such as poor patient adherence to antihypertensive therapy [16, 17], inadequate treatment [18] and other physician-related factors [19, 20], lifestyle choices and habits [21], socio-economic factors [22], and comorbidities [23].

In Russia, BP control is below the optimal. Oganov et al. reported that controlled BP was in 23–24% of patients with Htn in 2003–2010 [2]. Balanova et al. showed that BP control was achieved in 14.9% of patients with Htn in 2009–2010 years; in women it was higher then in men (19.3 vs 10.9%) [1]. The proportion of patients with achieved target BP (<140 mmHg) is very different among regions of Russia: from 6 to 86% [24, 25]. Probably, the factors associated with quality of BP control in Russian patients with Htn have a regional peculiarity.

The little is known about regional features of barriers to adequate BP control in Russian primary care. The primary objective of this study was to determine the impact of clinical factors on the achievement of target BP in hypertensive patients from one region (Ivanovo region) of the Central Federal District of Russia.

Ivanovo region is the most active participant of the Russian Registry of Hypertension, Coronary Artery Disease, and Chronic Heart Failure (RusR-Htn-CAD-CHF). Now, 4.2% (36,424 people) of adult population (875,513 people) of Ivanovo region is registered in this Registry. According to official data of Federal State Statistics Service of Russian Federation (http://www.gks.ru), the population of Ivanovo region was 1,036,900 people (44.9% male) in January 2015. It is 2.7% of population of the Central Federal District of Russia, and 0.7% of total Russian population (http://www.gks.ru). The main demographic characteristics of Ivanovo region are the following: the proportion of adult people is 84.4% (vs 82.4% in all-Russia), mean age of inhabitants is 41.5 years (vs 39.5 years in all-Russia), the proportion of urban people is 81.2% (vs 74.0% in all-Russia), and cardiovascular mortality among total population is 0.64% (vs 0.65% in all-Russia).

2 Methods

2.1 Data Source

The RusR-Htn-CAD-CHF [26] was used as a source of data on hypertensive patients from Ivanovo region of Russia. This Registry is a retrospective, continuous, nationwide, web-based registry operating online. Participation in the RusR-Htn-CAD-CHF is voluntary. The access to the registry is given only to registered members. The source of patients' data is a patients' medical card and/or hospital chart. Each patient fulfilled informed consent form prior to his/her data to be included in database of the RusR-Htn-CAD-CHF. Details on design of the RusR-Htn-CAD-CHF are presented in our previous publications [26, 27].

2.2 Patient Selection

Retrospective data on clinical characteristics, non-pharmacologic treatment, drug treatment, and reperfusion therapy (for hypertensive patients with coronary artery disease) contained in the 2015 RusR-Htn-CAD-CHF from 11,129 patients with Htn, living in Ivanovo region (Russia), were examined. The analyzed data included 81.2% of total patients with cardiovascular diseases (n = 13,708) registered in the 2015 RusR-Htn-CAD-CHF from Ivanovo region, and about 1.3% of adult population of Ivanovo region.

The average age of studied hypertensive patients was 61 (54, 68) years (data presented as median and inter-quartile ranges). 31.4% of patients were male. During 2015, these patients received ambulatory care in 17 health facilities located in Ivanovo region (Russia).

We used the following criteria to enroll the patients in our study:

(i) diagnosis of Htn signed in patients' medical card (data from the RusR-Htn-CAD-CHF),
(ii) age ≥18 years.

The patients were not included in our study if they matched the following criteria:

(i) secondary hypertension,
(ii) missing data on the BP, and treatment.

After inclusion in the study, all patients were stratified into two groups. Hypertensive patients, who achieved the target BP under treatment, were defined as TBP (target blood pressure) patients (n = 5109). The group defined as NTBP (non-target blood pressure) patients (n = 6020) included patients who did not achieve target BP under treatment. The achievement of target BP was considered as fulfilled if the patient had BP data during the last 12 months and the last value of BP was less than 140/90 mmHg. Thus, the frequency of achieving the target BP in patients with Htn from Ivanovo region, included in the 2015 RusR-Htn-CAD-CHF, was 45.9% that is comparable with other regions of Russia actively participating in this Registry in 2015 (for example, Saratov region—45.3%, Krasnoyarsk region—39.8%, and Altai region—

44.4%). The numbers and proportions of hypertensive patients, who were aware, treated, and controlled, in the overall population sample and in specific subsets of patients with diabetes, coronary artery disease, and chronic heart failure are presented in Table 1.

2.3 Clinical Factors

Clinical factors included in our analysis are consistent with the structure of database of the RusR-Htn-CAD-CHF [26]. According to the type of data, all factors can be stratified into continuous, categorical, and binary (Yes/No).

The continuous factors included age, height, left ventricular mass index, systolic and diastolic blood pressure (SBP and DBP), heart rate, weight and body mass index, waist circumference, blood glucose, total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein, left ventricular ejection fraction, creatinine, serum urea, uric acid, hemoglobin, and urine protein.

The following factors were binary: gender, old myocardial infarction, stable angina and other forms of chronic ischemic heart disease, chronic heart failure, prior stroke (including cerebral infarction, intracerebral haemorrhage, and stroke not specified as haemorrhage or infarction), atherosclerotic peripheral arterial disease, transient cerebral ischaemic attacks and related syndromes, discirculatory encephalopathy, dissecting aortic aneurysm, diabetes mellitus, chronic lower respiratory diseases, gout, pregnancy, cirrhosis of liver, family history of coronary artery disease and Htn, training in the School for hypertensive patients, medical advices (on alcohol consumption, smoking cessation, physical activity, healthy diet, and weight reduction), angiotensin converting enzyme inhibitors (ACE-Is), angiotensin II receptor blockers (ARBs), direct renin inhibitors, beta-blockers, calcium channel blockers (CCBs), diuretics, alpha-blockers, imidazoline receptor agonists, other antihypertensive drugs, statins, aspirin, and invasive treatment (for hypertensive patients with coronary artery disease).

The categorical factors included smoking, alcohol consumption, the level of physical activity in lifestyle, and balanced diet. Details about data structure are given in Appendix Table 7.

2.4 Design of Analysis

This study was approved by the local Ethics Committee of Saratov State Medical University n.a. V.I. Razumovsky (Saratov, Russia). First, we performed the comparison of TBP and NTBP patients in all studied clinical characteristics. In result, we have identified clinical peculiarities for each group. In addition, we evaluated the quality of clinical examination of patients, basing on the completeness of information on parameters in database of the RusR-Htn-CAD-CHF.

Next, we selected the clinical parameters for the discriminant function analysis. For the selection of parameters, we have used the following criteria:

(i) statistically significant differences between studied patients' groups on this parameter,
(ii) sufficient data completion in Registry database,
(iii) low association or absence of association with other parameters.

2.5 Statistical analysis

We applied the Shapiro–Wilk test to check whether the data were approximately normally distributed. Since some data occurred to be non-normal, their further analysis was carried out using non-parametric statistical methods. We applied the Chi-square (χ^2) test to compare the binary variables and to compute the significance level for the difference between two proportions. Mann–Whitney test was used to compare the continuous variables. Categorical and binary data were presented as frequencies and

Table 1 Numbers and proportions of hypertensive patients, who were aware, treated, and controlled, in the overall group and in some specific subsets

Specific subset of hypertensive patients	Total	Aware	Treated[a]	Controlled BP
Overall group of patients with Htn, no. (%)	11,129 (100)	11,129 (100)	10,406 (93.5)	5109 (45.9)
Hypertensive patients with diabetes, no. (%)	933 (100)	933 (100)	899 (96.4)	353 (37.8)
Hypertensive patients with CAD, no. (%)	805 (100)	805 (100)	780 (96.9)	318 (39.5)
Hypertensive patients with CHF, no. (%)	1041 (100)	1041 (100)	1010 (97.0)	311 (29.9)

The percentage is calculated with respect to the total number of patients in each specific subset

BP blood pressure, *CAD* coronary artery disease, *CHF* chronic heart failure, *Htn* hypertension

[a] Patients, who received the therapy with antihypertensive drug

percentages. Continuous variables were reported as medians (Me) and inter-quartile ranges (LQ, UQ).

Multiple associations between achieving the target BP and clinical factors were studied by logistic regression. ROC-analysis was used to identify cut-off points for continuous factors. The obtained estimations were considered statistically significant if $P < 0.05$.

3 Results

3.1 Characteristics of TBP and NTBP Patients

Clinical characteristics of TBP and NTBP patients enrolled in our study are presented in Tables 2, 3 and 4 and Appendix Table 7. It was found that TBP and NTBP patients differ in most clinical characteristics. NTBP patients had the following features in comparison with TBP patients:

(i) the proportion of women was slightly higher (Table 2),
(ii) they were slightly older than TBP patients (Table 2),
(iii) they were more likely to have co-morbidities (stable angina, chronic heart failure, old cerebral infarction, and diabetes mellitus) and family history of cardiovascular diseases (coronary artery disease and Htn) (Table 2),
(iv) they had slightly smaller prevalence of smoking, alcohol consumption, and poor diet; but larger prevalence of low physical activity (Table 2; Appendix Table 7),
(v) they had slightly higher values of body mass index, left ventricular mass index, total cholesterol, triglycerides, and hemoglobin (Table 3),
(vi) thee less of them attended the School for hypertensive patients and received advice on alcohol consumption, smoking cessation, healthy diet, and weight reduction (Table 4),

Table 2 General characteristics of the study population

Parameters	TBP patients (n = 5109)	NTBP patients (n = 6020)	P level
Male sex, %	32.9	30.2	0.002
Age, years, Me (LQ, UQ)	61 (53, 68)	62 (55, 69)	<0.001
Old myocardial infarction, %	2.8	2.3	0.078
Stable angina, %	2.0	4.4	<0.001
Other forms of chronic ischemic heart disease, %	2.9	3.2	0.334
Chronic heart failure, %	6.1	12.1	<0.001
Old cerebral infarction, %	2.1	2.9	0.011
Prior intracerebral haemorrhage, %	0.1	0	0.633
Prior stroke, not specified as haemorrhage or infarction, %	0.2	0.2	0.834
Atherosclerotic peripheral arterial disease, %	1.4	1.8	0.065
Transient cerebral ischaemic attacks and related syndromes, %	0.2	0.2	0.879
Discirculatory encephalopathy, %	5.8	6.1	0.524
Dissecting aortic aneurysm, %	0	0	–
Diabetes mellitus, %	6.9	9.6	<0.001
Chronic lower respiratory diseases, %	2.0	1.9	0.899
Gout, %	0.1	0.2	0.172
Pregnancy, %	0	0	–
Cirrhosis of liver, %	0	0	–
Family history of coronary artery disease, %	36.9	57.5	<0.001
Family history of hypertension, %	84.3	92.3	<0.001
Current smoker, %	10.6	8.3	<0.001
Alcohol drinking, %	25.6	21.1	<0.001
Low level of physical activity in lifestyle, %	12.5	13.9	0.030
Balanced diet, %	25.7	30.8	<0.001

Me (LQ, UQ) is median and inter-quartile ranges

NTBP patients hypertensive patients, who did not achieve the target blood pressure under treatment, *TBP patients* hypertensive patients, who achieved the target blood pressure under treatment

Table 3 Blood pressure levels and control rates, including the metabolic and haematological parameters

Parameters	TBP patients (n = 5109)	NTBP patients (n = 6020)	P level
SBP at last visit, mmHg, Me (LQ, UQ)	130 (125, 132)	145 (140, 150)	<0.001
DBP at last visit, mmHg, Me (LQ, UQ)	80 (75, 85)	90 (80, 95)	<0.001
Heart rate at last visit, beats/min, Me (LQ, UQ)	72 (68, 75); n = 1320	73 (71, 76); n = 1873	<0.001
Height, m, Me (LQ, UQ)	164 (160, 170); n = 2078	165 (160, 171); n = 2422	0.544
Weight, kg, Me (LQ, UQ)	76 (69, 85); n = 2149	80 (72, 88); n = 2434	<0.001
Body mass index, kg/m^2, Me (LQ, UQ)	27.7 (25.4, 31.1); n = 2076	29.0 (26.5, 32.4); n = 2422	<0.001
Waist circumference, cm, Me (LQ, UQ)	90 (82, 98); n = 562	90 (85, 98); n = 1661	0.092
LVEF, %, Me (LQ, UQ)	57 (45, 62); n = 56	59 (51, 63); n = 37	0.577
Left ventricular mass index, g/m^2, Me (LQ, UQ)	105 (103, 115); n = 443	115 (105, 125); n = 301	<0.001
Blood glucose, mmol/L, Me (LQ, UQ)	4.7 (4.5, 5.2); n = 3881	4.9 (4.5, 5.3); n = 4919	0.092
Total cholesterol, mg/dL, Me (LQ, UQ)	202 (186, 229); n = 4722	209 (190, 233); n = 5510	<0.001
Triglycerides, mg/dL, Me (LQ, UQ)	123 (97, 149); n = 1598	140 (105, 158); n = 2078	<0.001
Low-density lipoprotein, mg/dL, Me (LQ, UQ)	120 (95, 160); n = 453	112 (89, 147); n = 857	0.028
High-density lipoprotein, mg/dL, Me (LQ, UQ)	52 (40, 72); n = 314	68 (48, 84); n = 734	<0.001
Creatinine, mg/dL, Me (LQ, UQ)	0.9 (0.8, 1.0); n = 2692	0.9 (0.8, 1.0); n = 3367	0.215
Serum urea, mmol/L, Me (LQ, UQ)	5.5 (4.5, 6.4); n = 1572	5.4 (4.2, 6.4); n = 1932	0.112
Uric acid, μmol/L, Me (LQ, UQ)	272 (250, 320); n = 123	270 (240, 322); n = 143	0.796
Hemoglobin, g/L, Me (LQ, UQ)	137 (127, 145); n = 582	139 (130, 148); n = 771	0.001
Urine protein, g/L, Me (LQ, UQ)	0 (0, 0); n = 3297	0 (0, 0); n = 4681	0.863

Me (LQ, UQ) is median and inter-quartile ranges

DBP diastolic blood pressure, *LVEF* left ventricular ejection fraction, *NTBP patients* hypertensive patients, who did not achieve the target blood pressure under treatment, *SBP* systolic blood pressure, *TBP patients*, hypertensive patients, who achieved the target blood pressure under treatment

(vii) ACE-Is, ARBs, dihydropyridine CCBs, potassium-sparing diuretics, statins, and aspirin are often prescribed for NTBP patients. Thiazide diuretics are often used in TBP patients (Table 4),

(viii) Multi-drugs scheme of therapy is often prescribed for NTBP patients (Fig. 1),

(ix) TBP group has smaller number of patients who did not receive any antihypertensive drugs (4.5% in TBP patients vs 8.2% in NTBP patients) (Table 4).

However, clinical significance of the identified statistical differences in some clinical patients' characteristics between the studied groups should be discussed. Both groups of studied patients were characterized by incompleteness of information about the following clinical parameters: lifestyle (smoking, alcohol consumption, diet, and physical activity) (Appendix Table 7), heart rate, anthropometric indices (height, weight, body mass index, and waist circumference) (Table 3), echocardiographic indices (ejection fraction and mass index of left ventricle) (Table 3), blood biochemical indices (blood glucose, total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein, creatinine, serum urea, uric acid, and hemoglobin), and urine protein (Table 3).

Note that according to current guidelines [14], 1.7% of TBP patients and 23.6% of NTBP patients (see Fig. 1) had resistant Htn.

3.2 Association Between Patients' Clinical Characteristics and Achieving the Target BP in Hypertensive Patients

We selected clinical parameters for further multiple analysis basing on sufficient data completion and statistically significant difference between the studied patients' groups with respect to this parameter. The following parameters were included into multiple analysis: gender, age, stable angina, chronic heart failure, old stroke, diabetes mellitus, family history of coronary artery disease, family history of Htn, training in the School for hypertensive patients, advice on alcohol consumption, advice on smoking cessation, advice on diet, advice on physical activity, advice on weight reduction, ACE-Is, ARBs, dihydropyridine CCBs, thiazide diuretics, potassium-sparing diuretics, statins, and aspirin.

Beta-blockers were included additionally in the multiple analysis as the second destination frequency drug, despite the lack of difference in this parameter between TBP and

Table 4 Antihypertensive therapies and invasive treatment

Parameters	TBP patients (n = 5109)	NTBP patients (n = 6020)	P level
Non-pharmacologic treatment			
Subject trained in the SHP, %	34.2	32.1	0.019
Advice on alcohol consumption, %	25.0	14.1	<0.001
Advice on smoking cessation, %	17.8	9.0	<0.001
Advice on physical activity, %	38.5	39.6	0.250
Advice on healthy diet, %	39.7	42.0	0.014
Advice on weight reduction, %	36.3	32.3	<0.001
Drug treatment			
Patients without antihypertensive therapy, %	4.5	8.2	<0.001
ACE-Is, %	73.4	75.3	0.022
ARBs, %	10.8	12.6	0.004
Direct renin inhibitors, %	0	0.2	0.098
Beta-blockers, %	37.3	35.9	0.139
Dihydropyridine CCBs, %	6.8	9.0	<0.001
Non-dihydropyridine CCBs, %	2.4	2.8	0.232
Thiazide diuretics, %	36.9	32.8	<0.001
Potassium-sparing diuretics, %	9.0	11.9	<0.001
Loop diuretics, %	1.3	1.3	0.723
Alpha-blockers, %	0	0.1	0.357
Imidazoline receptor agonists, %	0.2	0.2	0.966
Other antihypertensive drugs, %	0.2	0.4	0.096
Statins, %	14.6	21.0	<0.001
Aspirin, %	20.1	28.0	<0.001
Invasive treatment			
PCI, %	0.5	0.3	0.052
Surgical coronary revascularization, %	0.1	0	0.126

ACE-Is angiotensin converting enzyme inhibitors, *ARBs* angiotensin II receptor blockers, *CCBs* calcium channel blockers, *NTBP patients* hypertensive patients, who did not achieve the target blood pressure under treatment, *PCI* percitaneous coronary intervention, *SHP* School for hypertensive patients, *TBP patients* hypertensive patients, who achieved the target blood pressure under treatment

NTBP patients. Alcohol consumption, weight and body mass index, smoking, balanced diet, and level of physical activity were excluded from the analysis due to insufficient data completion. However, these parameters had significant difference in TBP and NTBP patients.

We studied associations between achieving the target BP and selected clinical parameters in hypertensive patients. Results of logistic regression analysis are presented in Table 5. For the logistic regression, the cut-off point for age was identified as 55 years by ROC-analysis, Chi-square was 701.4 ($P < 0.001$), and percent of correctly classified cases was 66.2% for TPB patients and 72.7% for NTBP patients.

Therefore, the main clinical factors (with $P < 0.05$; Table 5) associated with achieving the target BP in studied patients with Htn were the advice on alcohol consumption, advice on smoking cessation, and advice on weight reduction. Thiazide diuretics, beta-blockers, and family history of Htn were the factors with a small positive effect on BP control.

The factors associated with poor BP control were the chronic heart failure, advice on healthy diet, potassium sparing diuretics, ARBs, ACE-Is, statins, age >55 years, dihydropyridine CCBs, and family history of coronary artery disease ($P < 0.05$; Table 5). Diabetes, old stroke, aspirin, training in the School for hypertensive patients, gender, and advice on physical activity were the factors having no effect on achieving the target BP (with $P > 0.05$; Table 5).

Associations between the poor BP control and some antihypertensive drugs may be caused by the prevalence of comorbidities in NTBP patients. We studied associations between some comorbidities (chronic heart failure and stable angina) and frequent prescription of multi-drugs

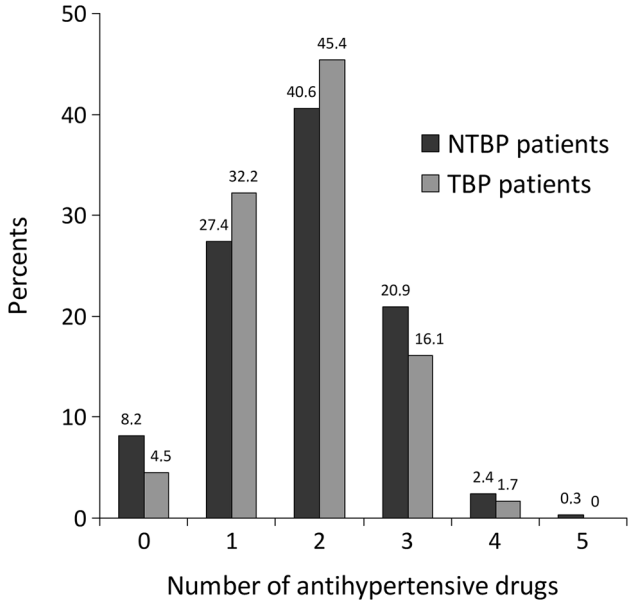

Fig. 1 Disctributions of number of antihypertensive drugs in TBP and NTBP patients. Mann–Whitney test results: Z(adjusted) = 3.24, P = 0.001

scheme of therapy. 20.9% of NTBP patients had three-component antihypertensive therapy (vs 16.1% in TBP group). We have shown strong association between the chronic heart failure and number of used antihypertensive drugs (logistic regression: Chi-square = 731.4, P < 0.001; Table 6). Similar result was obtained for stable angina (logistic regression: Chi-square = 213.7, P < 0.001; Table 6).

4 Discussion

According to our results, 45.9% of studied patients from Ivanovo region had target BP. With respect to other regions of Russia, Ivanovo region occupies an average place [24]. However, the mentioned percent is less than in a number of developed countries. Standard target BP was achieved only in 60.2% of Japanese hypertensive workers (<75 year old) without diabetes mellitus or chronic kidney disease and 30.5% of diabetic patients [28]. In Switzerland, 54% of all treated patients with Htn have target BP level, but BP

Table 5 Results of logistic regression analysis of association between achieving the target BP and clinical factors in hypertensive patients

Parameters	Odds ratio	95% CI	P level
Chronic heart failure	0.59	0.50–0.69	<0.001
Advice on healthy diet	0.63	0.52–0.75	<0.001
Potassium sparing diuretics	0.73	0.64–0.83	<0.001
ARBs	0.78	0.67–0.91	0.001
ACE-Is	0.79	0.71–0.88	<0.001
Stable angina	0.79	0.62–1.02	0.069
Statins	0.81	0.72–0.91	<0.001
Age >55 years	0.81	0.74–0.89	<0.001
Dihydropyridine CCBs	0.81	0.70–0.94	0.006
Family history of coronary artery disease	0.82	0.71–0.95	0.007
Diabetes	0.90	0.77–1.04	0.153
Old stroke	0.92	0.71–1.19	0.505
Aspirin	0.98	0.87–1.10	0.707
Training in the School for hypertensive patients	0.98	0.90–1.08	0.741
Male sex	0.99	0.92–1.11	0.992
Advice on physical activity	1.07	0.90–1.28	0.446
Family history of hypertension	1.12	1.01–1.24	0.043
Beta-blockers	1.12	1.03–1.21	0.009
Thiazide diuretics	1.21	1.10–1.32	<0.001
Advice on weight reduction	1.50	1.31–1.71	<0.001
Advice on smoking cessation	1.52	1.28–1.80	<0.001
Advice on alcohol consumption	1.78	1.53–2.07	<0.001

The data are presented in order of increasing Odds Ratio

CI confidence interval, *ARBs* angiotensin II receptor blockers, *ACE-Is* angiotensin converting enzyme inhibitors, *CCBs* calcium channel blockers

Table 6 Results of logistic regression analysis of association between comorbidities and multi-drugs scheme of antihypertensive therapy

Number of antihypertensive drugs	Odds ratio	95% CI	P level
Chronic heart failure vs multi-drugs scheme			
0	0.45	0.31–0.65	<0.001
1	0.20	0.15–0.26	<0.001
2	2.37	2.05–2.75	<0.001
3	6.81	5.15–9.02	<0.001
4	11.00	4.65–26.05	<0.001
5	30.01	6.04–149.13	<0.001
Stable angina vs multi-drugs scheme			
0	0.41	0.21–0.77	0.006
1	0.27	0.18–0.39	<0.001
2	1.85	1.45–2.35	<0.001
3	5.15	3.47–7.62	<0.001
4	9.05	3.27–25.01	<0.001
5	4.14	0.51–33.83	<0.001

control is still insufficient in diabetic patients and patients with impaired renal function [29]. In USA, 51.8% of adults with Htn have their blood pressure controlled [4], whilst a recent analysis reported about controlled BP in 60.6% of Italian hypertensive patients [8].

In the present study, we did not assess patient adherence to antihypertensive therapy basing on interviewing. Most patients from the studied region got medical advices (individual education) on different aspects of management of Htn and were trained in the School for hypertensive patients (group education). Moreover, advices on alcohol consumption, smoking cessation, and weight reduction were associated with achieving the target BP that indirectly demonstrates the impact of improving the individual patient education on BP control. The role of educational intervention in BP control is well known [30, 31]. Improvement of quality of educational work with hypertensive patients is also observed in some other regions of Russia (for example, Yaroslavl region [25]).

It is interesting to compare our results with the data from one Chinesse study of hypertensive patients [32]. The quality of educational work with patients was very different. It can be seen that in Ivanovo region, educational work among the hypertensive patients is much more active than in the studied Chinesse population of hypertensive patients. Moreover, in Ivanovo patients, only small part of subjects did not receive any antihypertensive therapy (4.5/8.2% in TBP/NTBP patients) in contrast to the Chinesse patients (48% of patients) [32]. These facts can be the reason of the difference in the frequency of achieving the target BP in these populations of hypertensive patients (45.9% in Ivanovo region vs 12.5% in Chinesse patients).

It is known that common factors of inadequate BP control in Russia are comorbidities (eg, obesity, and dyslipidemia) [23], poor patient adherence [33, 34], and nonadherence [35]. Shum et al. concluded that dyslipidemia and smoking cessation interventions with BP control are most important factors which can siginificantly improve the 10-year cardiovascular and economic outcomes in Russian hypertensive patients [36]. We confirm the influence of comorbidities (chronic heart failure and cardiovascular diseases requiring the prescription of statins) on the non-controlled BP in patients with Htn from Ivanovo region. Individual medical education of these patients (especially in older subjects, because age is non-modified factor to BP control), according to our results, increases the frequency of target BP, possibly by improving their adherence to Htn management. Note that age has high relation to the prevalence of Htn. Maksimov and Artamonova have shown that with ageing the role of other factors becomes more important for Htn development in Russia [15].

It is interesting to note that advice on healthy diet was significantly associated with poor BP control in studied patients with Htn, although other medical advices had the opposite effect. This may be an indirect evidence of the negative impact of this type of advice on the relationship of trust between the patient and his physician.

We have also received the results on the impact of antihypertensive drugs on BP control in the studied population of hypertensive patients. Antihypertensive therapy with beta-blockers and thiazide diuretics is the factor of achievement of target BP in patients with Htn, but it is secondary in importance to individual medical education of patients. Potassium sparing diuretics, ARBs, ACE-Is, and dihydropyridine CCBs were associated with poor BP control. The reason for this result is not obvious and requires further investigation. It is possible that this is due to the prevalence of comorbidities in NTBP patients, which requires more frequent prescription of multi-drugs

scheme of therapy. Other non-studied factors may also have influence on the revealed negative effect of some antihypertensive drugs.

We have not stidied annual dynamics of antihypertensive therapy in Ivanovo region. Mozheyko et al. Have reported that the antihypertensive therapy decreased in 15% in Ivanovo region from 2011 to 2014 [25]. For Yaroslavl region, these authors reported 16% increase in hypertensive drug consumption in 2011–2014 that determined the increase of patients with controlled BP from 17 to 33% [25]. The reasons of difference in the achievement of target BP between Ivanovo region (our results) and Yaroslavl region (data from [25]) requires a more detailed investigation. Percularities of design of these studies and regional features of Htn mangement have an impact on the results.

Thus, BP control is still the actual problem for Russian regions and Ivanovo region in particular. The frequency of achieving the standard target BP is still suboptimal. Similar situation is also observed in other countries [32, 37, 38]. There are still many unsolved issues concerning the regional differences observed in BP control rates in Russia. The similar problem attracts the attention of researchers in other countries. For example, Tocci et al. reported the marked regional differences in hypertensive treatment and control in Italy [39], which is explained not only by different prevalence of risk factors and comorbidities, and different geographical and atmospherical peculiarities of the Italian territories, but also by different availability and distribution of reference centers for Htn management and control. The necessity for such studies in Russia is obvious.

5 Potential Limitations

Both groups of studied patients were characterized by incompleteness of information, gathered during examination at ambulatory visits, about some clinical parameters that is described above in Sect. 3.1 and presented in Table 3 and Appendix Table 7. Thus, we cannot estimate the value of these parameters to achieve target BP in studied hypertensive patients, basing on multiple analysis.

We did not use interview questionnaires for studying the patients' adherence to antihypertensive therapy. This fact can reduce the validity of our results about the impact of studied factors on the achievement of target BP. Healthcare system factors and socio-economic factors contributing to poor compliance of hypertensive patients [40] were also not covered by our study.

6 Conclusion

We have identified regional factors of BP control in hypertensive patients from Ivanovo region of Russia. Individual medical education (in particular, advices on alcohol consumption, smoking cessation, and weight reduction) is the most important factor of optimal BP control. Comorbidities and age reduce the frequency of achieving the target BP. Antihypertensive therapy with beta-blockers and thiazide diuretics are less significant factors of optimal BP control in these patients. The reason of negative impact of other antihypertensive drugs (potassium sparing diuretics, ARBs, ACE-Is, and dihydropyridine CCBs) on BP control needs further investigation. Probably, it can be a result of the influence of other factors associated with the prescription of antihypertensive drugs (for example, comorbidity or factors not considered by us). Other studied clinical factors have no influence on BP control in patients with Htn from Ivanovo region.

Acknowledgements We thank all participants of the RusR-Htn-CAD-CHF involved in data collection for patients with Htn in Ivanovo region of Russia.

Compliance with Ethical Standards

Conflict of interest None declared. The RusR-Htn-CAD-CHF is funded by the Russian Ministry of Health as a part of the Health National Project. The Russian Ministry of Health was not involved in the collection, analysis, and interpretation of data; in the writing of this manuscript; or in the decision to submit the paper for publication. The authors have not received any financial support for the preparation of this paper.

Human rights statement For this type of study formal consent is not required.

Informed consent Informed consent was obtained from all individual participants included in the study.

Appendix

See Table 7.

Table 7 Smoking, alcohol consumption, physical activity, and diet in TBP and NTBP patients

Parameters	TBP patients (n = 5109)	NTBP patients (n = 6020)	P level
Smoking, %			<0.001
Current smoker: <1 cigarettes/day	1.6	0.7	
Current smoker: 1–9 cigarettes/day	3.9	3.6	
Current smoker: 10–19 cigarettes/day	4.5	3.4	
Current smoker: 20–39 cigarettes/day	0.5	0.6	
Current smoker: ≥40 cigarettes/day	0.1	0	
Former smoker	3.3	2.7	
Never smoked	37.4	42.0	
Unknown	48.8	47.0	
Alcohol consumption, %			<0.001
Alcohol drinking: <20 g/day	4.7	4.1	
Alcohol drinking: 20–59 g/day	14.7	11.9	
Alcohol drinking: 60–139 g/day	5.5	4.6	
Alcohol drinking: 140–179 g/day	0.6	0.5	
Alcohol drinking: ≥180 g/day	0.1	0	
No alcohol drinking	25.3	32.1	
Unknown	49.1	46.9	
The level of physical activity in lifestyle, %			<0.001
Low	12.5	13.9	
Medium	34.6	37.4	
High	5.6	3.5	
Unknown	47.2	45.2	
Balanced diet, %			<0.001
Yes	25.7	30.8	
No	25.6	19.7	
Unknown	48.6	49.5	

NTBP patients hypertensive patients, who did not achieve the target blood pressure under treatment, *TBP patients* hypertensive patients, who achieved the target blood pressure under treatment

References

1. Balanova Y, Timofeeva T, Konstantinov V, Koltunov I, Kapustina A, Lelchuk I, Muromsteva G, Deev A, Shalnova S. Epidemiology of hypertension in Russian Federation. Results of Federal Monitoring Program in 2003–2010: PP.16.03. J Hypertens. 2011;29:e291.
2. Oganov RG, Timofeeva TN, Koltunov IE, Konstantinov VV, Balanova YA, Kapustina AV, Lelchuk IN, Shalnova SA, Deev AD. Arterial hypertension epidemiology in Russia: the results of 2003–2010 federal monitoring. Cardiovasc Ther Prev. 2011;10:9–13.
3. Ong KL, Tso AW, Lam KS, Cheung BM. Gender difference in blood pressure control and cardiovascular risk factors in Americans with diagnosed hypertension. Hypertension. 2008;51:1142–8.
4. Nwankwo T, Yoon SS, Burt V, Gu Q. Hypertension among adults in the United States: National Health and Nutrition Examination Survey, 2011–2012. NCHS Data Brief. 2013;133:1–8.
5. Godet-Mardirossian H, Girerd X, Vernay M, Chamontin B, Castetbon K, de Peretti C. Patterns of hypertension management in France (ENNS 2006–2007). Eur J Prev Cardiol. 2012;19:213–20.
6. Briganti EM, McNeil JJ, Shaw JE, Zimmet PZ, Chadban SJ, Atkins RC, Welborn TA. Untreated hypertension among Australian adults: the 1999–2000 Australian diabetes, obesity and lifestyle study (AusDiab). Med J Aust. 2003;179:135–9.
7. Wilkins K, Campbell NR, Joffres MR, McAlister FA, Nichol M, Quach S, Johansen HL, Tremblay MS. Blood pressure in Canadian adults. Health Rep. 2010;21:37–46.
8. Tocci G, Nati G, Cricelli C, Parretti D, Lapi F, Ferrucci A, Borghi C, Volpe M. Prevalence and control of hypertension in the general practice in Italy: updated analysis of a large database. J Hum Hypertens. 2017;31:258–62.
9. Dzau VJ, Gibbons GH, Kobilka BK, Lawn RM, Pratt RE. Genetic models of human vascular disease. Circulation. 1995;2:521–31.
10. Nakanishi N, Nakamura K, Ichikawa S, Suzuki K, Tatara K. Lifestyle and the development of hypertension: a 3-year follow-up study of middle-aged Japanese male office workers. Occup Med (Lond). 1999;49:109–14.
11. Tsutsumi A, Kayaba K, Tsutsumi K, Igarashi M. Association between job strain and prevalence of hypertension: a cross sectional analysis in a Japanese working population with a wide

range of occupations: the Jichi Medical School cohort study. Occup Environ Med. 2001;6:367–73.
12. Mills P, Davidson K, Farag N. Work stress and hypertension: a call from research into intervention. Ann Behav Med. 2004;1:1–3.
13. Taylor JY, Sun YV, Hunt SC, Kardia SL. Gene-environment interaction for hypertension among African American women across generations. Biol Res Nurs. 2010;12:149–55.
14. Mancia G, Fagard R, Narkiewicz K, Redón J, Zanchetti A, Böhm M, Christiaens T, Cifkova R, De Backer G, Dominiczak A, Galderisi M, Grobbee DE, Jaarsma T, Kirchhof P, Kjeldsen SE, Laurent S, Manolis AJ, Nilsson PM, Ruilope LM, Schmieder RE, Sirnes PA, Sleight P, Viigimaa M, Waeber B, Zannad F. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). J Hypertens. 2013;31:1281–357.
15. Maksimov SA, Artamonova GV. Modeling of arterial hypertension's risk in occupational groups. Russ Open Med J. 2013;2:0104.
16. Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. The sixth report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC VI). Arch Intern Med. 1997;157:2413–46.
17. Odedosu T, Schoenthaler A, Vieira DL, Agyemang C, Ogedegbe G. Overcoming barriers to hypertension control in African Americans. Cleve Clin J Med. 2012;79:46–56.
18. Berlowitz DR, Ash AS, Hickey EC, Friedman RH, Glickman M, Kader B, Moskowitz MA. Inadequate management of blood pressure in a hypertensive population. N Engl J Med. 1998;339(27):1957–63.
19. Oliveria SA, Lapuerta P, McCarthy BD, L'Italien GJ, Berlowitz DR, Asch SM. Physician-related barriers to the effective management of uncontrolled hypertension. Arch Intern Med. 2002;162:413–23.
20. Wang L. Physician-related barriers to hypertension management. Med Princ Pract. 2004;13(5):282–5.
21. National Clinical Guideline Centre (UK). Hypertension: The Clinical Management of Primary Hypertension in Adults: Update of Clinical Guidelines 18 and 34 [Internet]. London: Royal College of Physicians (UK); 2011 Aug. (NICE Clinical Guidelines, No. 127.) 11, Lifestyle interventions. Available from: https://www.ncbi.nlm.nih.gov/books/NBK83262/.
22. Wee LE, Koh GC. Individual and neighborhood social factors of hypertension management in a low-socioeconomic status population: a community-based case-control study in Singapore. Hypertens Res. 2012;35:295–303.
23. Mozheyko M, Eregin S, Vigdorchik A, Hughes D. A cross-sectional survey of hypertension diagnosis and treatment practices among physicians in Yaroslavl Region, Russia. Adv Ther. 2012;29:1016–25.
24. Posnenkova OM, Korotin AS, Kiselev AR, Gridnev VI, Belova OA, Rachkova SA, Romanchuk SV, Dovgalevsky PYA, Oshchepkova EV. Performance of recommended measures on risk factors control in patients with hypertension, coronary artery disease and chronic heart failure: the data from 2014 Russian registry. Cardio-IT. 2014;2015(2):e0102.
25. Mozheyko M, Eregin S, Danilenko N, Vigdorchik A, Tobe SW, Campbell N, McLean D, Baskakova Z, Klimovskaia I, Ramanathan K, Hughes D. Hypertension in Russia: changes observed after 4 years of a comprehensive health system improvement program in the Yaroslavl region. J Clin Hypertens (Greenwich). 2017;19:198–204.
26. Gridnev VI, Kiselev AR, Posnenkova OM, Popova YV, Lazareva NV, Belova OA, Romanchuk SV, Prokhorov MD, Dovgalevsky PYA, Oshchepkova EV. Objectives and design of Russian Registry of Hypertension, Coronary Artery Disease, and Chronic Heart Failure. Russ Open Med J. 2017;6:e0201.
27. Oshchepkova EV, Dovgalevsky PY, Gridnev VI, Posnenkova OM, Kiselev AR, Dmitriev VA, Popova YV, Volkova EN. User guide of Russian registry of patients with arterial hypertension, coronary artery disease and chronic heart failure. Cardio-IT. 2014;1:0204.
28. Kudo N, Yokokawa H, Fukuda H, Sanada H, Miwa Y, Hisaoka T, Isonuma H. Achievement of target blood pressure levels among japanese workers with hypertension and healthy lifestyle characteristics associated with therapeutic failure. PLoS One. 2015;10:e0133641.
29. Schäfer HH, Sudano I, Theus GR, Noll G, Burnier M. Target blood pressure attainment with antihypertensive therapy in Swiss primary care. Blood Press. 2012;21:211–9.
30. Wang L, Li J. Role of educational intervention in the management of comorbid depression and hypertension. Blood Press. 2003;12:198–202.
31. Whitworth JA, World Health Organization, International Society of Hypertension Writing Group. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens. 2003;21:1983–92.
32. Yi-Bing W, De-Gui K, Long-Le M, Le-Xin W. Patient related factors for optimal blood pressure control in patients with hypertension. Afr Health Sci. 2013;13:579–83.
33. Kobalova ZD, Starostina EG, Kotovskaia IV, Villeval'de SV, Baranova EI, Bogachev RS, Volkova NI, Drozdetskiĭ SI, Kisliak OA, Koziolova NA, Kolina IG, Krasnova IN, Lopatin IM, Maksimenko VV, Negoda SV, Tarlovskaia EI, Tiukalova LI, Khokhlov RA, Freĭdlina MA. Antihypertensive treatment compliance and obstacles to its improvement. Results of Russian program ARGUS-2. Ter Arkh. 2008;80(3):76–82.
34. Roberts B, Stickley A, Balabanova D, McKee M. Irregular treatment of hypertension in the former Soviet Union. J Epidemiol Community Health. 2012;66:482–8.
35. Greenberg HM, Galyavich AS, Ziganshina LE, Tinchurina MR, Chamidullin AG, Farmer RG. Identification and management of patients with hypertension in the polyclinic system of the Russian Federation. Am J Hypertens. 2005;18:943–8.
36. Shum K, Alperin P, Shalnova S, Boytsov S, Kontsevaya A, Vigdorchik A, Guetz A, Eriksson J, Hughes D. Simulating the impact of improved cardiovascular risk interventions on clinical and economic outcomes in Russia. PLoS One. 2014;9:e103280.
37. Rayner B. Hypertension: detection and management in South Africa. Nephron Clin Pract. 2010;116:c269–73.
38. Schmieder RE, Goebel M, Bramlage P. Barriers to cardiovascular risk prevention and management in Germany—an analysis of the EURIKA study. Vasc Health Risk Manag. 2012;8:177–86.
39. Tocci G, Nati G, Cricelli C, Parretti D, Lapi F, Ferrucci A, Borghi C, Volpe M. Prevalence and control of hypertension in different macro-areas in Italy: analysis of a large database by the general practice. High Blood Press Cardiovasc Prev. 2016;23:387–93.
40. Jin J, Sklar GE, Min SOV, Chuen LS. Factors affecting therapeutic compliance: a review from the patient's perspective. Ther Clin Risk Manag. 2008;4:269–86.