Blood pressure control in tertiary-care hypertensive patients during COVID-19 pandemic

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Abstract

Background: Cardiovascular risk factors distribution during the pandemic suggests worsening of the cardiovascular risk profile of hypertensive patients. At the same time, data on quality of hypertension control during the COVID-19 pandemic are scarce, in Poland. The aim of the study was to analyse the quality of blood pressure (BP) control in a group of patients who required regular control in tertiary care.

Material and methods: The study included patients regularly monitored in Gdańsk Hypertension Centre for at least 4 years with at least 2 visits a year prior the analysis. The size of the group was calculated based on the original data of first 50 consecutive records of patients (power of 90%). Records were retrospectively analysed with respect to office blood pressure (oBP) control. Additionally, within-visit BP variability was calculated (difference of maximum and minimum BP from 3 measurements); body weight, age, sex, duration of hypertension, number of visits per year, seasonal BP variability, use of telemedical services, comorbidities and BP-lowering treatment were recorded.

Results: The study enrolled 220 patients. The values of systolic BP (sBP) before and after the break in the whole group were 135.8 ± 17.1 mm Hg *vs.* 137.9 ±19.5 mm Hg; P=0.08, and a diastolic BP (dBP) of 80.3 ±11.4 mm Hg *vs.* 82.6 ±12.2 mm Hg; p = 0.001. After adjusting for seasonal variation of BP, the respective differences were: sBP: 134.8 ± 16.5 *vs.* 138.0 ± 19.4; p = 0.03, and dBP: 79.4 ±10.9 *vs.* 82.2 ± 11.9; p = 0.004. Before 2020, 61.4% of patients were controlled (BP < 140/90 mm Hg), whereas after the pandemic-driven break in regular visits the control rate decreased to 55.5% (p = 0.21).

Conclusions: BP increased significantly and the rate of BP control decreased during the COVID-19 pandemic in a group of patients requiring tertiary care for hypertension.

Key words: office blood pressure; COVID-19 pandemic; telemedicine

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Introduction

The worldwide rate of adequate blood pressure (BP) control in hypertensive patients is varying enormously across countries [1]. In addition, an alarming trend has been reported from the United States where a decline in the number of BP-controlled patients was reported in the 2017 to 2020 NHANES survey [2]. In Poland, the last nationwide BP control survey available (NATPOL 2011 study) was carried out in 2011. The NATPOL 2011 Study provided office BP (oBP) data recorded on two separate visits in 2413 subjects aged 18-79 among whom 72% were aware of their hypertension (HTN) [3]. In this survey, the rate of control of hypertension (BP < 140/90 mm Hg) was at 22.4% (including those who knew and did not know about their hypertension), and 35.7% among patients who were already aware of their hypertension. To date, most large scale data sets related to BP control have been collected during the pre-pandemic COVID-19 era.

Before the pandemic, the utilization of telemedicine was vaguely standardized in Poland and its use was mainly related to drug prescriptions. The COVID-19 pandemic not only substantially increased the number of tele-health consultations but also modified their character. Patients were thoroughly consulted by phone including full medical history, signs and symptoms, laboratory tests, BP readings and many more. Additionally, neither physicians nor patients had both practice and an adequate access to the technology required to optimally utilize telemedicine services [4]. In addition to functional reorganisation of the health-care systems during the pandemic (rarefication of in-person visits as a consequence of imposed lock-down, common implementation of telemedicine services) both pandemic-related lifestyle changes, stress, and COVID-19 itself might have altogether affected BP control in the years 2020–2022. Likewise other cardiovascular risk factors [5], hypertension control might have worsened during the pandemic.

Therefore, we decided to compare the quality of BP control in tertiary care outpatient hypertension clinic based on office BP readings before, and after the 2nd and 3rd waves of COVID-19 pandemic.

Material and methods

We have analysed retrospectively the records of hypertensive patients regularly visiting the tertiary-care out-patient clinic of the Department of Hypertension and Diabetology, University Clinical Centre MUG, Gdańsk, Poland. We have focused primarily on the control of office BP and changes in body weight in two time-points. The baseline assessment took place during the last visit before the COVID-19 pandemic outbreak in our country. These data were then compared with data recorded during the first physical visit in doctors' offices when the majority of social restrictions and lock-down were withdrawn (gap no shorter than 9 months in-between two consecutive visits). To avoid bias related to substantial pharmacotherapy modification (typically following therapy initiation), and related to diagnostic procedures (e.g. primary aldosteronism screening), only records of patients with a 4-year medical history, at minimum, were analysed. Each patient had documented two or more visits yearly over the period of 4 years preceding the pandemic outbreak. Sample size (n = 220) was calculated based on the individual dataset of the first fifty patients with the following assumptions: paired two-tailed t-test, power = 90%; p < 0.05, difference in systolic BP of 4 mm Hg.

Blood pressure measurements were performed by a trained nurse or technician during preparatory visit directly prior doctors' consultation, as a standard. Validated Omron HEM-7321-E devices were utilized [6, 7], and ESH 2018 guidelines related to BP measurement were applied [8]. In addition to systolic and diastolic BP, a within visits' variability (WVV) of systolic BP was estimated (calculated as the difference between first and third office systolic BP reading) [9, 10].

In addition to BP measurements and weight assessment other variables were collected and tabulated i.e. age, sex, hypertension duration, number of visits per year, duration of COVID-19-related interval in office visits, presence of tele-health services, comorbidities, BP-lowering drugs used before, during, and after the break (drug-group, dose and potential drug modifications during and/or after the break and use of single-pill combination) were evaluated.

Statistical analysis

Data were entered in MS Excel Spreadsheet (Microsoft Co). Statistical analyses were performed with a standard statistical package (STATISTICA StatSoft, Inc., version 12, www.statsoft.com). Shapiro-Wilk was employed to test for normality of data distribution. Data were averaged and presented as means ±SD or Median (first quartile; Q1, fourth quartile; Q4) depending on the distribution. Continuous variables were compared with t-test or Mann-Whitney test as appropriate. Chi-squared test was applied to compare proportions between the groups. A p-value of less than 0.05 was considered as statistically significant.

Results

The clinical characteristics of total 220 patients before and after the pandemic are presented in Table 1. Table 2 shows antihypertensive treatment before, during and after the COVID break. The median time-interval between two in-person consecutive visits during the pandemic was 18 months (Q1 = 15; Q4 = 24). The majority of patients were subjected to remote health consultations during the pandemic outbreak (212/220).

As shown in Table 1, body weight did not differ in the analysed group when assessed at the last pre-pandemic visit *vs*. first visit in the later course of the pandemic. Similarly, mean systolic BP did not differ in the whole group i.e.: 135.8 ± 17.1 mm Hg *vs*. 137.9 ± 19.5 mm Hg (p = 0.08) (Tab. 3). However, mean diastolic BP was higher after the pandemic break in in-person visits, i.e.: 80.3 ± 11.4 mm Hg *vs*. 82.6 ± 12.2 mm Hg (p = 0.001). To eliminate interfering effect of seasonal changes in BP values, we reanalysed data with respect to months when two visits were scheduled (before and after the pandemic gap). A total of 130 patients had the post-pandemic control visit in the same season as the last pre-pandemic one (range of 4 months). In this group, sBP was + 3.2 mm Hg (134.8 ± 16.5 *vs*. 138.0 ± 19.4 mm Hg; p = 0.03) higher in the second visit and the same was observed with dBP (+2.8 mm Hg, 79.4 ± 10.9 *vs*. 82.2 ± 11.9 mm Hg; p = 0.004). Additionally, in the subgroup of patients with well-controlled BP pre-pandemic (BP within the age-adjusted norms) systolic BP was significantly higher after the gap: 125.0 ± 8.7 mm Hg before *vs*. 133.5 ± 17.8 mm Hg after the break (p = 0.002). This was not the case for patients with uncontrolled hypertension who tended to improve their BP based on office readings: 150.6 ± 16.0 before *vs*. 142.4 ± 20.8 after the break (p = 0.002).

Before the pandemic adequate BP control (defined as a BP < 140/90 mm Hg) was achieved in 135 patients (61.4%) which decreased to 122 patients (55.5%) after the break (p = 0.21). The age-adjusted BP-control i.e. < 130 for patients younger than 65 years of age, and < 140 mm Hg for older than 65 years, accounted for 39.1% of patients before the pandemic and 36.8% after the pandemic (p = 0.62).

Within visits variability (WVV) increased from 10.7 ± 9.3 mm Hg before the pandemic to 14.2 ± 10.0 mm Hg after the break (p < 0.0001). The increase in WVV was more evident when the analysis was limited to patients who had their visits in the same year season i.e. 10.3 ± 9.1 *vs*. 15.8 ± 10.4 (p < 0.0001).

As shown in Table 2, the only significant changes in antihypertensive medications were a decrease in the prescription of calcium channel blockers and an

Table 1 Clinical characteristic of the study group

Anthropometrics			
Age [y.o.]	66.5 ± 12.5		
Women/Men	106 (48.2%)/114 (51.8%)		
Height, m	1.7 ± 0.1		
	Pre-pandemic	**After the pandemic break**	**P-value**
Weight, kg	86.2 ± 21.7	86.6 ± 21.8	0.27
Comorbidities			
Coronary artery disease	40 (18.2%)	42 (19.1%)	0.16
Congestive heart failure	12 (5.5%)	14 (6.4%)	0.16
Chronic lung disease	17 (7.7%)	18 (8.2)	0.32
History of stroke	40 (18.2%)	43 (19.5%)	0.08
Chronic kidney disease	28 (12.7%)	30 (13.6%)	0.16
OSA symptoms	27 (12.3%)	30 (13.6%)	0.08
Hypercholesterolemia	174 (79.0%)	178 (80.9%)	0.045
Type 2 diabetes mellitus	54 (24.5%)	57 (25.9%)	0.18
Thyroid gland disease	52 (23.6%)	52 (23.6%)	1.00

Data presented as mean ± standard deviation (SD), median (Q1; Q4), n (%); where appropriate. p-values for paired T-test, Mann-Whitney *U* test, χ^2 test; where appropriate. Age calculated, and height measured after the pandemic-induced break. OSA — obstructive sleep apnea

Table 2. Antihypertensive drug treatments prescribed before, during and after the COVID-19 pandemic break

BP-lowering drug group	Pre-pandemic	During pandemic	After the pandemic break	p-value
ACEi	98 (44.5%)	101 (45.9%)	101 (45.9%)	0.37
ARB	105 (47.7%)	102 (46.4%)	102 (46.4%)	0.26
CCB	142 (64.5%)	133 (60.5%)	133 (60.5%)	0.01
BB	151 (68.6%)	156 (70.9%)	161 (73.2%)	0.001
Alpha-blocker	43 (19.5%)	41 (18.6%)	40 (18.2%)	0.26
Alpha and beta dual receptor blocker	2 (0.9%)	2 (0.9%)	2 (0.9%)	1.00
Nitrate	2 (0.9%)	3 (1.4%)	3 (1.4%)	0.32
CNS-acting	0 (0.0%)	1 (0.5%)	1 (0.5%)	0.32
Alpha-adrenergic agonist	0 (0.0%)	0 (0.0.%)	0 (0.0%)	1.00
Thiazide diuretic	120 (54.5%)	117 (53.2%)	124 (56.4%)	0.32
Loop diuretic	33 (15.5%)	37 (16.8%)	33 (15.5%)	1.00
Potassium-sparing diuretic	46 (20.9%)	46 (20.9%)	52 (23.6%)	0.06
SPC	100 (46.1%)	102 (47.0%)	104 (48.0%)	0.25

Data presented as n (%). p-values for paired T-test. p-values calculated for pre-pandemic and after the pandemic break values. BP — blood pressure; ACEi — angiotensin-converting enzyme inhibitor; ARB — angiotensin receptor blocker; CCB — calcium channel blocker; BB — beta-blocker; CNS — central nervous system; SPC — single-pill combination

Table 3. Hypertension treatment, hypotensive therapy modifications, blood pressure values

Hypertension treatment			
Hypertension duration [y.o.] (SD)	23.8	10.7	
Out-patient clinic care duration [y.o.] (SD)	13.3	7.0	
No. of visits per year	2	(2; 2)	
No. of patients who had teleconsultations	212	96.4%	
Hypotensive therapy modifications during the break in personal visits			
No modifications	148	67.3%	
By out-patient clinic	42	19.1%	
By other physician	13	5.9%	
By patient himself	5	2.3%	
More than 1 modification	12	5.5%	
Hypotensive therapy modifications after the break in personal visits			
	81	36.8%	
	Pre-pandemic	**After the pandemic break**	**p-value**
Mean SBP	135.8 ± 17.1	137.9 ± 19.5	0.08
Mean DBP	80.3 ± 11.4	82.6 ± 12.2	0.001
No. of BP-lowering drugs	3 (2.5; 4)	3 (3; 4)	0.24
Within visit variability of systolic BP	10. ± 9.3	14.2 ± 10.0	< 0.0001

Data presented as mean ± standard deviation (SD), median (Q1; Q4), n (%); where appropriate. p-values for paired T-test, Mann-Whitney *U* test, χ^2 test; where appropriate. SBP — systolic blood pressure; DBP — diastolic blood pressure; BP — blood pressure

increase in that of beta-blockers after the pandemic break. The prescription of blockers of the renin-angiotensin system remained unchanged. During the remote consultations (Tab. 3), 42 patients (19.1%) required modification of their antihypertensive therapy i.e.: BP-lowering drugs were increased in 19 cases (8.6%), whereas the reduction of doses was applied to 14 (6.4%) patients. Additionally, 30 patients (13.6%) had their BP-lowering drugs modified by general practitioners, other specialists, or patients themselves without any consultation, as documented during the first post-pandemic visit.

Discussion

The present results show that the pandemic-induced break in regular in-office visits resulted in a worsening of BP control in chronic hypertensive patients monitored in a tertiary care setting. After several months of social distancing, patients had higher office systolic and diastolic BP particularly when measurements from the same season of the year were compared (to avoid natural, seasonal BP variations). In addition, a greater within visit BP variability was observed suggesting an enhanced alert response evident in the later course of pandemic. These observations may result from several factors including in-person visits rarefication coinciding with insufficient telemedicine-based health-care standards during COVID-19 pandemic. A history of COVID-19 infection, and/or unhealthy lifestyle changes may have also contributed to the worsening of BP control in hypertensive patients.

In the United States, BP control worsening during COVID-19 pandemic was also reported by Shah et al. [11]. In this large-scale data analysis of home BP records obtained from digital health platform, showed both systolic and distolic increases by 2 mm Hg, and 0.5 mm Hg, respectively [11]. Similar trend was also shown by Chamberlain et al. who reported decrease of fraction of patients with satisfactory controlled BP by 7.2% (from 60.5% to 53.3% based on data from National Patient-Centered Clinical Research Network (PCORnet) Blood Pressure Control Laboratory Surveillance System) [12]. Contrary to their findings, Brazilian national survey, in which office BP and home BP were evaluated, showed no significant changes in BP control over the course of the pandemic [13]. Surprisingly, an Italian study by Pengo et al. reported that home BP during COVID-19 was either comparable or even lower as referred to pre-pandemic data [14].

One of the possible reason for discrepancies in the reports on BP control may be different levels of telemedicine-based solutions introduced to health-care systems prior the pandemic [15, 16].

In Poland, telemedicine-based health-care was vaguely implemented prior the pandemic outbreak, in particular in the specialist outpatient entities. In fact, before the year 2020, the vast majority of telephone-based contacts between patients and physicians was related to drugs prescriptions only. The widespread implementation and modifications of telemedicine standards during the pandemic might have contributed to worsening of blood pressure control in chronic hypertensive patients. Over the analysed period (median 18 months) ninety six percent of patient from our cohort was subjected to telephone consultations served by doctors from our Centre. Nevertheless, during the first personal visit, 36.8% of patients had uncontrolled office BP which justified antihypertensive treatment modification. It is rather unexpectedly high portion of patients who required drugs modification, given that patients were rather stable in terms of BP control prior pandemic for the past few years (an inclusion criterion was 4 years of our Centre record, at minimum). It is not possible to decide whether COVID-19 infection itself (it was challenging to track the true cases), rarefication of personal visits, pandemic-related restrictions, everyday routine changes, or clustering of factors to elevate BP during pandemic were causative for high fraction of patients with uncontrolled BP after the pandemic-induced break. Another factor which we attempted to control was the contribution of patients' self-made decisions on drugs modifications. This could be related to chaotic communications on ACEi and ARBs therapy at the early stage of pandemic [17, 18]. Nevertheless, only 2.3% of patients admitted that they decided to change the therapy by themselves (Tab. 3). All things considered, even if we sum together all patients who had their drugs incorrectly modified by physicians (5%) with patients who modified drug regimen by themselves, the total of 7% of patients do not explain 1/3 of a cohort with uncontrolled hypertension after the pandemic-induced break.

Interestingly, our study suggests that the rarefication of hypertension-related office visits provoked by pandemic negatively affected BP control mainly in those patients who were well-controlled as documented by the last pre-pandemic office recordings. One of the possibilities that could partly explain this observation is regression towards the mean phenomenon, however loosening patient-healthcare provider physical link might have contributed to poorer BP control.

Kreutz et al. documented that several months of COVID-19 pandemic resulted in aggravation and/or accumulation of other known cardiovascular risk factors, many of which could have contributed to higher BP among others: sleep disruption, weight gain, sodium consumption increase and potassium consumption decrease, larger amounts of spirit-containing beverages consumption, job-loss threat, stress, depression, etc. [5]. We were unable to track most of the aforementioned data in our retrospective analysis, however 18 months (15;24) of social distancing induced by COVID-19 pandemic apparently did not promote patients' body weight gain in our cohort. Although our study was not designed to have sufficient power to detect body weight changes, our results are in line with other reports [14, 19, 20]. Relatively stable body weight in our patients may be somewhat surprising as repetitive lock-downs favoured physical inactivity [5, 19].

Systolic BP WVV was more evident upon first office visit in the late course of pandemic as compared with the last pre-pandemic visit (increase by 4 mm Hg for systolic PB net difference; p < 0.0001). It is not possible to decide whether the documented phenomenon was dependent on pandemic-related stress, COVID-19 infection or irregularities in in-person visits. The sBP WVV depicts stress response induced by a physician/nurse presence, and it is not exactly the same as white coat effect where out of office readings are necessary (home or 24-hour BP monitoring). The large cross-sectional studies provided some information on the extend of the WVV in office in the pre-pandemic times. The authors of the May Measure Month (MMM) study, conducted in 2017 and 2018, have calculated the difference between the first and third blood pressure measurement. In their cohorts of more than 1 million volunteers, the blood pressure decreased on average by 2.9/1.5 mm Hg, systolic and diastolic, respectively [21, 22]. There are also estimates on how different factors influencing the blood pressure measurement could actually influence the blood pressure level in the office measurement. The actual white coat effect having the largest influence, with only minor blood pressure changes (systolic and diastolic alike) with insufficient resting period or no influence of interval between the measurements [23].

Although we are not aware of the direct associations of WVV with cardiovascular risk there are suggestions that WVV may correspond with visit-to visit BP changes [24, 25]. This however, is a well-known factor to negatively influence cardiovascular risk. Long term BP variability may negatively influence cardiovascular morbidity and mortality [23, 26, 27]. Our observation suggests that COVID-19 pandemic could have contributed to this phenomenon.

Lastly, seasonal blood pressure variability should be taken into account when interpreting our results (office BP in the coldest months are higher as compared to BP readings in the summertime) [28, 29]. Seasonal changes in northern hemisphere are estimated at 2.9 mm Hg and 1.4 mm Hg for SBP and DBP respectively [30], therefore we decided to control this factor with an additional analysis of our dataset. Patients who had their both visits in the same year season (irrelevant whether warm or cold season of the year) had significantly higher BP after the pandemic-induced break (net difference for systolic BP accounted for 3.2 mm Hg, p = 0.03 and for diastolic BP = 2.8 mm Hg, p = 0.004).

Limitations

We identify some shortcomings of our analysis among which limited population may be of relevance. However, as stated in the methods, we calculated power to detect 4 mm Hg effect in systolic BP difference. Additionally, our data come from one centre which may not translate to other populations. To mitigate, we would like to stress that we comply with universal standards as proposed by European Society of Hypertension in guidelines, statements, and position papers. Additionally, we analysed data of office BP readings, yet several studies showed that 24-BP monitoring better depict BP-related cardiovascular risk [8, 31]. We would like to stress the fact, that most guidelines refer to evidence from clinical trials which were based on office BP readings. As for today, office BP monitoring still serves as the basis for diagnosis and one of the foremost methods for monitoring of BP control. Finally, we had no information on whether the patients had COVID infection during the 2 years of the analysis timeframe.

Conclusion

To summarize, we report on modest but significant BP rise induced by COVID-19 pandemic break in personal visits in patients requiring tertiary care for hypertension.

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