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ORIGINAL ARTICLE

White Coat Uncontrolled Hypertension in Teleconsultation: A New and Frequent Entity

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Abstract

Introduction Cardiovascular risk seems not to be greater in patients with white coat uncontrolled hypertension (WUCH) than in patients with sustained blood pressure (BP) control. Therefore, its detection is important to avoid overtreatment. The COVID-19 pandemic determined a massive migration of hypertension consultations from the face-to-face modality to teleconsultations, and it is unknown whether WUCH exists in this context.

Aim We aimed to evaluate the prevalence of WUCH through home BP monitoring (HBPM) in treated hypertensive patients evaluated by teleconsultation.

Methods We included treated hypertensive patients that owned a digital BP monitor. During teleconsultation, patients were asked to perform two BP measurements and then a 7-day HBPM, using the same device. Patients were classified as having WUCH if BP was ≥ 140 and/or 90 mmHg in teleconsultation and < 135/85 mmHg on HBPM. The prevalence of WUCH and its 95% confidence interval were estimated. One-way ANOVA, the Chi-square test or Fisher's exact test were used to compare the characteristics of these patients with the other groups.

Results We included 341 patients (45.2% male, mean age 62.3 years). The prevalence of WUCH was 33.1% (95% CI 28.3–38.3%). Significant differences were found in terms of age, the number of antihypertensive drugs and the use of calcium channel blockers, all lower in the WUCH group as compared with the groups with elevated BP on HBPM.

Conclusion WUCH exists in teleconsultation and is very frequent. It can be easily detected though HBPM, thus avoiding overmedication, and its potential impact on side-effects and health costs.

Keywords Teleconsultation · Home blood pressure monitoring · White uncontrolled hypertension · Masked uncontrolled hypertension · High blood pressure

1 Introduction

Telemedicine has become an essential tool to provide care to patients, given the need for isolation imposed by COVID-19 [1]. In many hospitals, like ours, the onset of the pandemic led to a massive migration of all scheduled outpatient visits to teleconsultations. Given that hypertension is currently considered the leading cause of death and disability [2], maximizing efforts for its adequate control in the context of the pandemic is crucial. For several years, the assessment of blood pressure (BP) outside the office has been considered a fundamental part of the management of hypertensive patients. Of the two recommended techniques [3, 4], ambulatory blood pressure monitoring (ABPM) and home blood pressure monitoring (HBPM), the latter has been repositioned as an invaluable tool, since not only is it similar to

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ABPM (and better tolerated than it) for many of the indications of routine clinical practice, but it can also be performed with the patient being at home all the time, transmitting the information to the health care professional by various means.

When measuring BP inside and outside the consultation, medicated hypertensive patients fall into one of four categories, depending on whether their BP is controlled or not within and/or outside the consultation [5]. Two of these categories, white coat uncontrolled hypertension (WUCH, i.e. inadequate control in the consultation and adequate control outside the consultation) and masked uncontrolled hypertension (MUCH, i.e. opposite phenomenon to WUCH) have aroused special interest. In patients with WUCH, the risk seems not to be greater than that of hypertensive patients with sustained BP control [6, 7], so detection of the phenomenon is important to avoid overtreatment; on the other hand, the risk in individuals with MUCH is high [6]. However, in the current context where "office BP" has been transformed into "teleconsultation BP", it is unknown whether these phenomena exist and occur with the same frequency as when BP is measured in the office. Therefore, we aimed to evaluate the prevalence of WUCH detected through HBPM in hypertensive patients under treatment who carried out their controls through teleconsultation.

2 Methods

2.1 Study Population

This was a cross-sectional study that consecutively included hypertensive patients 18 years or older treated in the Hypertension Section of the Hospital Italiano de Buenos Aires and who were under stable antihypertensive treatment for at least 4 weeks. These patients had to have a digital blood pressure monitor at home. Pregnant women, patients with < 12 readings on the HBPM and those who refused the informed consent procedure were excluded. The study protocol was approved by the local ethics committee (*Comité de Ética de Protocolos de Investigación [CEPI]*, aproval #5621), and all patients who agreed to participate provided informed consent.

2.2 BP Measurements and Other Procedures

In our institution, teleconsultations use an application developed by the Department of Health Informatics, integrated into the Electronic Medical Record and the Personal Health Record of patients, without the need to use an external platform to prescribe medication or request and/or view studies [8]. During teleconsultation, patients were asked to perform two BP readings (1 minute apart), using their device in the non-dominant arm, after 5 min of rest and in a sitting position. The average of these measurements was used for the analysis. The brand and model of the equipment used were recorded and then the websites www.dableducational.org and https://bpm.medaval.ie/accurate-lists/ were searched in order to determine whether the devices used by the patients were validated. Anthropometric and demographic variables were also recorded, as well as the characteristics of the antihypertensive treatment and laboratory data (fasting plasma glucose, total cholesterol and serum creatinine) from 12 months before teleconsultation.

The patients were then asked to perform a 7-day HBPM with BP measurements in the non-dominant arm and sitting, in the morning and evening (in duplicate, 1 min apart) [9], using the same equipment used in the teleconsultation (instructional email and form to be completed was sent to the patients) and starting the day after the teleconsultation was carried out. The average of the measurements was calculated, discarding first day of readings as currently recommended by HBPM guidelines [9, 10].

2.3 Definition of Clinical Parameters

According to a cutoff BP value of < 140/90 mmHg in the teleconsultation and < 135/85 mmHg in the HBPM to consider BP under control, patients were classified as having: (1) adequate sustained BP control, if BP was controlled in both situations; (2) inadequate sustained BP control BP was elevated in both situations; (3) WUCH, if BP was elevated in teleconsultation and controlled during HBPM; (4) MUCH, when BP was normal in teleconsultation and elevated during HBPM [5].

2.4 Statistical Considerations

2.4.1 Sampling, Sample Size Calculation and Statistical Analysis

We performed a systematic sampling, with a random starting point on the date the first patient was included and sampling interval = 1. Sample size was estimated assuming a prevalence of WUCH of 16.8% and a prevalence of MUCH of 12.4%, according to previous data from our hospital [11]. For a precision of ± 4% and a confidence level of 95%, the minimum number of patients to be recruited was calculated in 336 for estimating the prevalence of WUCH, and 261 for estimating the prevalence of MUCH. We assumed a possible loss rate of 5% and, therefore, the final number of participants to be recruited was 353.

Table 1 Baseline characteristics of the study population

n	341
Male sex (%)	45.2
Age, years (SD)	62.3 (13.9)
Smoking habits	
Current smoker (%)	5.6
Former smoker (%)	26.4
Diabetes (%)	12.6
Dyslipidemia (%)	62.2
History of ischemic heart disease (%)	3.8
History of cerebrovascular disease (%)	4.7
BMI, kg/m^2 (SD)	28.9 (4.9)
Fasting plasma glucose, mg/dL (IQR)	100 (91–108)
Creatinine, mg/dL (IQR)	0.92 (0.76–1.1)
Total cholesterol, mg/dL (SD)	185.4 (38.4)

BMI body mass index, *IQR* interquartile range, *SD* standard deviation

Table 2 Characteristics of antihypertensive treatment

Number of antihypertensive drugs (SD)	2.1 (1)
Diuretics (%)	26.1
Beta-blockers (%)	36.1
ACEI (%)	31.7
ARB (%)	52.8
CCB (%)	50.1
Aldosterone antagonists (%)	5.9
Alpha-blockers (%)	2.3
Other (%)	0.9

ACEI angiotensin-converting enzyme inhibitors, *ARB* angiotensin receptor blockers, *CCB* calcium channel blockers, *SD* standard deviation

Categorical variables are reported as percentage, and continuous variables as mean±standard deviation, or median and interquartile range, according to data distribution.

The prevalences of WUCH and MUCH were estimated with their 95% confidence intervals, and the characteristics among the four groups of patients were compared, using one-way ANOVA for continuous variables, and the Chi-square test or Fisher's exact test for categorical ones.

3 Results

The study included 354 hypertensive patients. Of them, 13 had less than 12 readings on HBPM. Therefore, 341 participants were finally included in the analysis. The patients characteristics are depicted in Table 1. Briefly, mean age was 62.3 years, 45.2% were men, 12.6% had diabetes and 8.5% had a history of cardio or cerebrovascular disease. As stated in the Methods section, all study subjects were under treatment. On average, they were taking 2.1 antihypertensive drugs (Table 2), and had a mean BP of 140.1/83.2 mmHg during teleconsultation and of 127.5/77.5 mmHg on HBPM (Table 3). 63.3% of participants used a validated BP monitor, with Omron (Omron, Tokyo, Japan) being the most common brand.

The prevalence of WUCH was 33.1 % (95% CI 28.3–38.3%) whereas the prevalence of MUCH was 7.9% (95% CI 5.5–11.3%). In turn, the prevalences of adequate and inadequate sustained BP control were 31.4 (95% CI 26.7–36.5%) and 27.6 (95% CI 23.1–32.6%), respectively. There were no significant differences in these figures when comparing validated vs non validated devices: WUCH: 30.6 vs 37.6%, p = 0.18; MUCH: 7.4 vs 8.7%, p = 0.65.

Table 4 depicts the characteristics of the four categories of patients: adequate sustained BP control, inadequate sustained BP control, WUCH and MUCH. Besides the predefined differences in BP levels, significant differences were found in terms of age, the number of antihypertensive drugs taken and the use of calcium channel blockers, all of which were higher in the MUCH and inadequate sustained control groups.

4 Discussion

In our study, we found a prevalence of WUCH and MUCH of 33.1 and 7.9%, respectively, when BP was measured during teleconsultation. Patients with MUCH and sustained uncontrolled hypertension were older, took a higher number of antihypertensive drugs and the use of calcium channel blockers was more common.

In general, the prevalence of WUCH has been described to be about 15-25% of individuals attending hypertension clinics [12], a lower figure than that obtained in our study. On the other hand, the prevalence of MUCH is reported to be around 10–20% [5, 12], slightly higher than our findings. Moreover, in a study conducted in our institution a few years ago, in a very similar population than that participating in the present study, we found a prevalence of WUCH and MUCH of 16.8 and 12.4%, respectively, when office BP was measured at the clinic and out-of-office BP was measured through HBPM [11]. Regarding the International Database of Home Blood Pressure in Relation to Cardiovascular Outcome (IDHOCO), one of the largest HBPM databases worldwide, the prevalence of WUCH was 15.9% [6], also a lower figure as compared with the findings of this study, where "office BP" was actually "teleconsultation BP". Therefore, it seems that WUCH might be more common in teleconsultation than in a face-to-face visit to the office. Many explanations have been provided for the "white coat effect", first described by Mancia et al. in 1983

Table 3 Blood pressure profiles in teleconsultation and during home blood pressure monitoring

BP in teleconsultation	
SBP 1, mm Hg (SD)	142.8 (14.2)
DBP 1, mm Hg (SD)	83.8 (10.2)
HR 1, bpm (SD)	73.4 (11.9)
SBP 2, mm Hg (SD)	137.4 (14.3)
DBP 2, mm Hg (SD)	82.6 (9.9)
HR 2, bpm (SD)	71.9 (11.8)
Mean SBP, mmHg (SD)	140.1 (13.6)
Mean DBP, mmHg (SD)	83.2 (9.6)
Mean HR, bpm (SD)	72.6 (11.7)
HBPM	
Number of BP readings (SD)	27.6 (1.8)
7-day SBP, mmHg (SD)	127.7 (11.7)
7-day DBP, mmHg (SD)	77.7 (7.2)
Mean HR, bpm (SD)	69.1 (9.3)
SBP discarding first day measurements, mmHg (SD)	127.5 (11.3)
DBP discarding first day measurements, mmHg (SD)	77.5 (7.3)
Morning SBP, mmHg (SD)	126.3 (12.8)
Morning DBP, mmHg (SD)	77.4 (7.6)
Evening SBP, mmHg (SD)	128.5 (12.5)
Evening DBP, mmHg (SD)	77.6 (7.6)

BP blood pressure, *BPM* beats per minute, *DBP* diastolic blood pressure, *HBPM* home blood pressure monitoring, *HR* heart rate, *SBP* systolic blood pressure, *SD* standard deviation

[13]. On the one hand, the white coat phenomenon may be a neuro-endocrine reflex conditioned by anticipation of having BP measured and the fear of what this measurement may indicate concerning future illness [14]. On the other hand, it seems to be an activation of skin nerves with concomitant sympathetic inhibition of muscle nerve-traffic, a kind of "defense reaction", regulated by diencephalic areas that adjusts the cardiovascular response to emotional behavior including anxiety [15]. In fact, Jhalani et al. found a significant association between anxiety during a clinic visit and the white coat effect [16], which has been confirmed in other [17]. We speculate that, during the teleconsultation, additional stressors like the anxiety generated by the use of new technologies (teleconsultation platform), problems related to internet connection, and/or the presence of a relative (many times required by elderly people to handle the technological aspects of teleconsultation) who is observing the BP measurement, could constitute an explanation for the higher prevalence of WUCH in this setting. Since we have no information regarding the actual presence of a relative during teleconsultation, this hypothesis is purely speculative. Another possible explanation for this finding is the fact that patients were managed by a hypertension center and not by a primary care physician. We also hypothesize that the teleconsultation could provide a different perspective for the typical asymmetric doctor-patient relationship in which WUCH is inserted: classically, the white coat activates the phenomenon and the patient plays a passive role, whereas during the teleconsultation, the patient is very active, using his/her BP monitor and communicating what pressure he/she took by him/herself. In this sense, the observed rise in BP might be due to a unique phenomenon, with different consequences, that are worth investigating further.

Identifying cases of WUCH is not a minor issue: in the aforementioned IDHOCO database, white-coat hypertension assessed by home measurements was a cardiovascular risk factor in untreated but not in treated subjects [6]. Moreover, a meta-analysis conducted by Huang et al. that included 8656 individuals under antihypertensive treatment found that neither the risk of cardiovascular events, nor total mortality increased in association with WUCH in this group [18]. As a consequence, the detection of this phenotype would avoid unnecessary treatment intensification, with may have related side effects and lead to an increase in costs.

Some particular characteristics have been described in subjects with white coat hypertension and/or WUCH [19–21], especially when ABPM is used as the out-of-office BP measurement method. For instance, in the Spanish

Table 4 Comparison of patients with sustained controlled hypertension, white coat uncontrolled hypertension, masked uncontrolled hypertension and sustained uncontrolled hypertension

Characteristic	SCH (n = 107)	WUCH (n = 113)	MUCH (n = 27)	SUCH (n = 94)	p value
Male sex (%)	40.2	44.3	51.9	50	0.48
Age, years (SD)	59.6 (13.6)	61 (12.8)	66.7 (12.6)	65.8 (14.8)	0.003
Smoking habits					
Current smoker (%)	6.5	6.3	7.4	6.4	0.93
Former smoker (%)	27.1	24.8	29.6	26.6	0.93
Diabetes (%)	13.1	14.2	11.1	17	0.36
Dyslipidemia (%)	63.6	58.4	66.7	63.8	0.78
History of ischemic heart disease (%)	2.8	2.7	3.7	6.4	0.49
History of cerebrovascular disease (%)	7.5	3.5	0	4.3	0.31
BMI, kg/m^2 (SD)	29.3 (5.5)	28.5 (4.9)	29.1 (3.2)	29.1 (4.6)	0.68
Fasting plasma glucose, mg/dL (SD)	101.5 (17.5)	99.5 (12.3)	107.9 (14)	103.7 (18)	0.07
Creatinine, mg/dL (SD)	0.9 (0.2)	0.96 (0.4)	1.02 (0.4)	1 (0.3)	0.13
Total cholesterol, mg/dL (SD)	185.6 (37.7)	181.7 (37.1)	185.6 (27.5)	189.9 (43.3)	0.06
BP in teleconsultation					
Mean SBP, mmHg (SD)	127 (8.6)	147.8 (9.1)	130.7 (7.6)	148.5 (10.5)	< 0.001
Mean DBP, mmHg (SD)	78.8 (7)	86.2 (9)	75.8 (8.2)	86.6 (10.2)	< 0.001
Mean HR, bpm (SD)	73.6 (13.2)	72.9 (10.8)	70.4 (8.3)	71.7 (11.6)	0.50
HBPM 7-day SBP, mmHg (SD)	118.7 (7.8)	124.5 (6.3)	137.2 (7.6)	139.1 (10.2)	< 0.001
7-day DBP, mmHg (SD)	75.1 (5.7)	76.1 (6.4)	80.3 (7.2)	81.8 (7.8)	< 0.001
Mean HR, bpm (SD)	70.9 (9.7)	68 (8.1)	69.7 (10.7)	68.3 (9.4)	0.10
SBP discarding first day measurements, mmHg (SD)	118.6 (7.9)	124 (6.3)	137.6 (7.9)	139 (10.3)	< 0.001
DBP discarding first day measurements, mmHg (SD)	75 (5.8)	75.8 (6.4)	80.1 (7)	81.8 (7.8)	< 0.001
Morning SBP, mmHg (SD)	117.8 (8.9)	122.4 (7.7)	137.1 (9.6)	137.7 (12.2)	< 0.001
Morning DBP, mmHg (SD)	74.9 (6.2)	75.6 (6.7)	80.3 (7.8)	81.6 (8.3)	< 0.001
Evening SBP, mmHg (SD)	119.4 (8.6)	125.5 (8)	137.5 (9.9)	140.1 (10.7)	< 0.001
Evening DBP, mmHg (SD)	75.2 (6.1)	75.9 (7.1)	79.6 (6.7)	81.9 (8.3)	< 0.001
Number of antihypertensive drugs (SD)	1.9 (0.9)	1.9 (1)	2.4 (1)	2.3 (1)	0.004
Diuretics (%)	22.4	23.9	37	29.8	0.34
Beta-blockers (%)	34.6	35.4	40.7	37.2	0.93
ACEI (%)	29	38.1	22.2	29.8	0.29
ARB (%)	52.3	44.3	63	60.6	0.08
CCB (%)	46.7	38.9	66.7	62.8	0.002
Aldosterone antagonists (%)	5.6	6.2	7.4	5.3	0.98
Alpha-blockers (%)	0.9	3.5	3.7	2.1	0.6
Other (%)	0	0.9	3.7	1.1	0.33

ACEI angiotensin-converting enzyme inhibitors, *ARB* angiotensin receptor blockers, *BMI* body mass index, *BP* blood pressure, bpm beats per minute, *CCB* calcium channel blockers, *DBP*, diastolic blood pressure, *HR* heart rate, *MUCH* masked uncontrolled hypertension, *SBP* systolic blood pressure, *SCH* sustained controlled hypertension, *SD* standard deviation, *SUCH* sustained uncontrolled hypertension, *WUCH* white coat uncontrolled hypertension

ABPM registry, Banegas et al. found that, in treated hypertensives, age ≥ 60 years, female sex, non-smokers, the absence of diabetes and having a lesser target-organ damage were independent predictors of WUCH [22]. On the other hand, Rimpelä et al. proposed two novel candidate genes, SPG7 and RASGEF1B, associating with the white coat effect [23]. However, when HBPM is used as the out-of-office BP measurement technique, fewer features consistently associated with WUCH have been found. In a meta-analysis conducted by Sheppard et al., female sex was the only significant predictor of white coat hypertension (OR 3.38, 95% CI 1.64–6.96), while many other predictors were

related to masked hypertension [24]. In our study, only three variables (younger age, lesser number of antihypertensive drugs and lesser use of calcium channel blockers) were significantly associated with WUCH. We believe this warrants more research in the field of WUCH detected through HBPM to establish characteristics consistently associated with the phenomenon, preferably through multivariable analyses, that may help to detect independent contributors to this phenomenon.

Finally, our findings must be interpreted in the context of the study limitations. First, the time in which the patients took their antihypertensive medication was not controlled; second, drug adherence was not formally tested; third, our population is representative of Argentine middle-class-medicated hypertensive patients, mainly from European descent. Therefore, our results may not be generalizable to other populations. Probably, the main study limitation is that home BP measurements were self-reported by the patients and not teletransmitted directly from their BP devices. Reporting bias rates vary widely in the medical literature, from 0.014 to 36% [25]. According to Myers and Stergiou, patients often have their own special reasons for reporting either high or low BP readings to the physician in routine clinical practice. For example, some patients may be more concerned about high BP readings and their risks, whereas others are more fearful of taking medication and the potential for adverse effects [25]. Some studies have found that patients tend to report lower than higher BP readings in their logs as compared with the device´s memory [26, 27]. However, when patients are aware of their participation in a research study, like in our case, the level of reporting accuracy tends to improve. In a study conducted by Schwartz et al., for example, 89.6% of submitted readings were accurate compared with corresponding downloaded monitor readings [28]. The authors hypothesize that this could be due to the Hawthorne effect, i.e. subjects modifying their behavior in response to their awareness of being observed [29]. Our study also has some strengths: it is, to our knowledge, the first study that demonstrates the presence and high prevalence of WUCH during teleconsultation; it uses HBPM as the out-of-office measurement method, which is not only the recommended technique for the follow up of patients already under treatment (given its acceptability, availability and lower costs in comparison to ABPM) [3–5, 12], but also an irreplaceable tool in the context of COVID 19 pandemic since it allows remote control with the patient being at home all the time [9, 30]; and it provides a unique opportunity to empower patients by encouraging them to take active behaviors such as self-measuring BP during the consultation.

5 Conclusion

In conclusion, WUCH exists in teleconsultation and is very frequent, being present in one out of three patients. It can be easily detected though HBPM, avoiding over-medicating the patient, thus avoiding the potential impact that this could have on side-effects and health costs.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Data and/or code availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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