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The importance of blood pressure measurements at the emergency department in detection of arterial hypertension

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Abstract

Background: *Arterial hypertension (AH) is the most important modifiable risk factor for cardiovascular diseases in Poland and around the world. Unfortunately, despite its potentially catastrophic consequences, more than 30% of hypertensive patients in Poland remain undiagnosed. Therefore, emergency department (ED) triage may play a role in screening of a significant proportion of the population. The present study aimed to assess the prevalence of hypertension in patients reporting to the ED by verifying ad hoc measurements with ambulatory blood pressure monitoring (ABPM).*

Methods: *The study included 78,274 patients admitted to the ED of the University Clinical Center in Gdansk from 01.01.2019 to 31.12.2020, with elevated blood pressure values (systolic blood pressure [SBP] > 140 mmHg and/or diastolic blood pressure [DBP] > 90 mmHg) during triage according to the inclusion and exclusion criteria.*

Results: *Out of 34,597 patients with SBP > 140 mmHg and/or DBP > 90 mmHg, 27,896 patients (80.6% of patients) had previously been diagnosed with AH. Finally, a group of 6701 patients with elevated values of arterial blood pressure in triage, who had not yet been diagnosed with AH, was identified. This accounted for 8.6% of patients admitted to the ED. Ultimately, 58 patients (26 women and 36 men) agreed to undergo ABPM. Based on the analysis, AH 32 patients were diagnosed with AH (55.2%).*

Conclusions: *The ED plays an essential role in diagnosing hypertension among people reporting to the ED for various reasons. There is a high probability of a diagnosis of AH in a group of patients who have elevated blood pressure values during triage and have not yet been diagnosed with hypertension.* (Cardiol J)

Key words: arterial hypertension, emergency department, triage, ambulatory blood pressure monitoring

Introduction

Arterial hypertension (AH) is the most important modifiable risk factor for cardiovascular diseases in Poland and around the world [1]. The basis for diagnosing AH is the measurement of arterial blood pressure (BP) in the office performed using an indirect method. It is possible to diagnose AH when the mean BP values calculated from at least two different measurements taken on two

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different visits are equal to or are higher than 140 mmHg for systolic blood pressure (SBP) and/or 90 mmHg for diastolic blood pressure (DBP) [2]. BP measurements should be performed using the correct technique after preparing the patient for the examination and with the use of an appropriate apparatus meeting the measurement accuracy criteria [3]. Because hypertension cannot always be excluded based on correct outpatient clinic measurements, automatic blood pressure measurement (ABPM), which is usually conducted over 24 hours, can provide valuable clinical information [4]. Subsequent measurements are made automatically every 15–30 minutes during an active period and every 30–60 minutes during sleep [2]. A large number of regular measurements in the patient's everyday life conditions may allow for a much more reliable assessment of the actual BP [5]. Normal BP values in ABPM are mean values below 135/85 mmHg during the day and below 120/70 mmHg during the night, and below 130/80 mmHg throughout the day.

Hypertension, the leading cause of premature deaths, affected 31.1% of the population in 2010 (1.39 billion people) [6]. Although the value of mean BP and the prevalence of hypertension have been decreasing in developed countries since the 1970s [7], it still affects over 150 million people in Europe [8].

Hypertension is called the "silent killer". Despite the potentially fatal consequences, its symptoms (classically related to this disease: headache, epistaxis, arrhythmias, visual disturbances, tinnitus, fatigue, nausea, and chest pain) appear once the disease is advanced [9]. The number of patients with undetected AH in the United States of America is estimated at 13 million [10]. Compared to Poland, based on the NATPOL PLUS study, the number of people suffering from hypertension who are aware of their diagnosis was estimated at 66% (women 73%, men 60%) [11]. Socio-economic factors are said to have a negative impact on the diagnosis of AH. In the case of low-income patients, immigrants, or certain ethnic groups, there is a lower chance of detecting hypertension [12, 13]. Due to the difficulties resulting from asymptomatic hypertension in groups of patients who have not yet been diagnosed, it should be remembered that early detection of hypertension is crucial to avoid its complications [14].

In 2020, 239 ED were operating in Poland, out of which 154 emergency rooms (ER) cooperated with the State Medical Rescue system. Patients who report to the ER or ED are provided with health services in two modes: outpatient and inpatient (followed by hospitalization in other departments). In 2020, the ER and the ED provided emergency medical assistance on an outpatient basis to over 3.2 million people (which gives an index of 120 ED/ER visits per 1000 inhabitants per year) [15]. These numbers were even higher in 2019 — almost 4.6 million people were provided with assistance without the further need for inpatient hospitalization (160 visits per 1000 inhabitants) [16].

The study had two phases: a retrospective and a prospective one. The retrospective phase of the present study aimed to assess the number of ED patients who were not previously diagnosed with AH and whose BP measured during triage exceeded the typical values.

A prospective observational study was conducted to examine whether high BP at triage was a hypertension predictor.

Methods

Study design and setting

The study was carried out in the Emergency Department at the University Clinical Center in Gdansk, Poland. Enrollment and data collection occurred between January 2019 and December 2020. The first stage of the study was based on the analysis of data from the hospital's IT system (Clininet; CompuGroupMedical, Lublin, Poland). The MedStream Designer program (MSD, Transition Technologies S.A., Warsaw, Poland), compatible with the hospital's Clininet system was used to obtain patient data. This tool allowed us to obtain specific information from the hospital's IT system according to criteria defined by the researcher with anonymization of the data. Furthermore, in the prospective phase of the study, patients with increased values of BP observed during triage were invited to undergo an ABPM procedure to verify whether they were suffering from AH.

The current study was approved by the Bioethics Committee at the Medical University of Gdansk (approval number NKBBN/513/2018).

Participants

In the first stage of the study, anonymized data of 78,274 adult patients hospitalized in the ED from 01.01.2019 till 31.12.2020 were analyzed. Eligible subjects were at least 18 years of age, had their BP measured at triage, and had complete data on their medical history, including AH.

In the second phase of the study, patients were included once they gave written consent to participate and had their BP elevated at triage ≥ 140/90 mmHg (SBP values, DBP values or both). Subjects were excluded if they were pregnant, had behavioral or psychiatric problems, had previously been diagnosed with hypertension, were currently treated with hypotensive medication, or used psychostimulants.

Study procedures

All subjects admitted to the ED undergo medical triage, with BP measurement being its essential part. First, BP measurement was performed at rest (accordingly to European Society of Hypertension guidelines). Then, after identifying a patient with high BP at triage, another measurement was performed after 2 minutes to confirm the previous result. Finally, if the BP was still at least 140/90 mmHg, a careful, structured medical interview was carried out (reason for visiting ED, comorbidities, medication, allergies, exposure to tobacco smoke or psychostimulants). Pain intensity was measured with a visual analogue scale routinely used in the department. Apart from the BP measurements, patients had their heart rate, pulse oximetry, and temperature (measured on the tympanic membrane) taken with a Welch Allyn Connex Spot Monitor and had blood samples taken for laboratory analysis (sodium, potassium, creatinine, and blood urea nitrogen in serum). Patients whose BP was dangerously high (≥ 180/110 mmHg) were hospitalized for further observation and treatment. Patients who could safely continue diagnostics on an outpatient basis were offered participation in the ABPM study. The ABPM was performed with the use of the Space Lab 90207 apparatus, which was set up in the morning on the day of the patient's arrival. Blood pressure measurements were taken for 24 hours, every 30 minutes. After the ABPM results were processed and interpreted, the patient received information about the diagnosis (or exclusion) of hypertension. According to the European Society of Hypertension guidelines, mean values below 135/85 mmHg during the day, 120/70 mmHg at night, and below 130/80 mmHg during the 24-hour period were considered to be normal values.

Data analysis

All calculations were performed using the IBM SPSS 23 statistical package and the Excel 2016 spreadsheet. Qualitative variables were presented using counts and percentages, and quantitative variables were characterized using the arithmetic mean and standard deviation. The significance of differences between the two groups was inspected with the Student t-test for independent samples. In order to find the relationship, strength, and direction between the variables, a correlation analysis was used to calculate the Spearman correlation coefficients. The features of normal distribution in the analyzed groups were verified using the Kolmogorov-Smirnov test. The χ^2 test was used for qualitative variables. In all calculations, $p \leq 0.05$ was assumed as the level of significance. In order to verify the hypothesis as to whether there was a high probability of a diagnosis of arterial hypertension in patients with elevated arterial pressure in the triage, Student t-tests were used.

Results

Out of 78,274 patients visiting ED from 01.01.2019 to 31.12.2020, 34,597 had their BP elevated at triage. In 27,896 patients, hypertension has already been identified. 6701 (8.6% of all patients admitted to ED) had elevated BP values without a previous diagnosis of AH. 254 patients were invited to participate in the present study, out of which 129 gave written consent. Ultimately, 58 patients (26 women and 36 men) underwent ABPM. The average time between the visit to the ED and the patient's appointment for the 24-hour BP measurement was 2.91 ± 2.25 days.

The mean age in the group was 44.12 ± 14.11. Among the patients in the study group, 25.4% were diagnosed with chronic diseases (n = 15), and 15.3% (n = 9) smoked tobacco (Table 1). The most common comorbid disease was hypothyroidism (n = 3) (Table 2). 23.7% of patients (n = 14) were taking prescribed medications.

The results of laboratory tests were analyzed and no significant deviations from the norm were found. The mean serum potassium concentration was 4.25 ± 0.36 mmol/L, sodium 139.5 ± ± 2.6 mmol/L. None of the patients had laboratory evidence of kidney injury. The mean serum creatinine concentration was 1.22 ± 0.18 mg/dL, urea nitrogen 14.14 ± 4.24 mg/dL. None of the results exceeded the laboratory norms.

In order to verify the diagnosis of AH, an analysis of the ABPM was performed. Mean daily SBP values were 129.19 ± 11.58 mmHg, while mean daily DBP values were 78.22 ± 9.43 mmHg. The mean daily SBP values during the active period were 133.28 ± 12.24 mmHg, and the mean daily DBP values during the active period were 81.88 ± 9.87 mmHg. During the night rest period, the mean SBP was 117.61 ± 20.28 mmHg, DBP 68.73 ± 13.84 mmHg.

Table 1. Characteristics of the study group.

Characteristics of the study group	N	Percent
Gender		
Male	32	44.8%
Female	26	55.2%
Age		
20–30	10	17.2%
31–40	16	27.6%
41–50	13	22.4%
51–60	9	15.5%
61–70	7	12.1%
> 70	3	5.2%
Tobacco use		
Yes	8	13.8%
No	50	86.2%
Pharmacotherapy (regardless of the cause)		
Yes	14	24.1%
No	45	75.9%
Comorbidities		
Yes	15	25.9%
No	44	74.1%
Cause of emergency department presentation		
Minor trauma	21	36.2%
Abdominal pain	9	15.6%
Headache	7	12%
Ophthalmological emergencies	7	12%
Lower back pain	6	10.3%
Chest pain	4	6.9%
Ear emergency	4	6.9%
Total number	58	100%

Table 2. Comorbidities in the study group.

Comorbidities	N	Percent
Hypothyroidism	3	5.1%
Bronchial asthma	1	1.7%
Coronary artery disease	1	1.7%
Diabetes	1	1.7%
Gastritis	1	1.7%
Hashimoto disease	1	1.7%
Atherosclerosis	1	1.7%
Migraine	1	1.7%
Obesity	1	1.7%
Sjogren's syndrome	1	1.7%
Rheumatoid arthritis	1	1.7%
Supraventricular tachycardia	1	1.7%
Kidney tumor	1	1.7%
Total number	15	25.4%

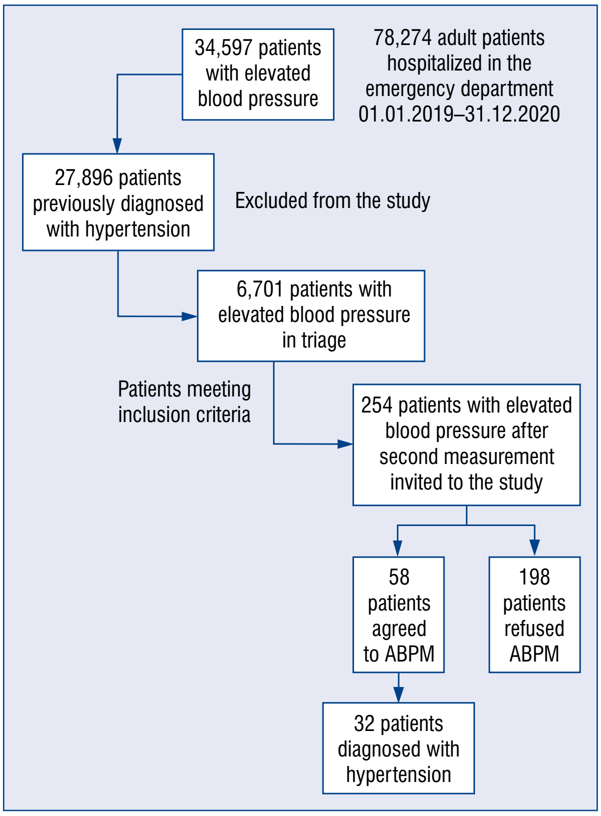

Figure 1. Study design; ABPM — ambulatory blood pressure monitoring.

Out of the 58 patients who reported for an ABPM, hypertension was diagnosed in 32 (55.2%) subjects (Fig. 1). The analysis showed that statistically significantly higher SBP was observed in patients diagnosed with hypertension (t (56) = 2.61; p = 0.011). The mean value of SBP in ABPM in patients diagnosed with AH was 168.06 ± 19.9 mmHg, while in the group without a hypertension diagnosis, the mean value was 156.57 ± 11.32 mmHg. There were no significant differences between the DBP values and the diagnosis of the disease (t (56) = 1.67; p = 0.097).

There was no statistically significant correlation between the SBP (rHO = –0.05; p = 0.712) and DBP (rHO = 0.09; p= 0.518) and the pain level on the visual analogue scale.

The Student t-test showed that statistically significantly higher SBP (t (56) = 2.16; p = 0.035) and DBP (t (56) = 1.95; p = 0.05) occurred in men than in women.

Discussion

Arterial hypertension, one of the most common chronic diseases, is often found as a comorbid disease in patients seeking help in EDs. According to the NATPOL 11 and WOBASZ II studies, the prevalence of AH in the Polish population ranges from 32% to 42.7% [11, 17]. In the study by Backer et al. [18], among ED patients, the percentage of elevated BP values was higher than in the general population. This phenomenon, associated with stress, pain, and the dissimilarity of the population reporting to EDs, is confirmed in the meta-analysis by Armitage et al. [19]. In the present study, BP was elevated in 44.2% of ED visitors. This result is similar to the prevalence of AH in the general population.

The study by Mahdi et al. [20] included 41,455 patients admitted to hospitals on an emergency basis. The authors estimated the prevalence of previously undiagnosed hypertension at 5% [20], which is in line with another study by Arhami Dolatabadi et al. [21], who assessed the frequency of undiagnosed AH in the population of patients reporting to the ED at 4.8%. Furthermore, Svenson and Repplinger [22] estimated that the prevalence of undetected hypertension among adult patients was at 3–15%. In the current study, in 6701 (19.4%) patients who had elevated BP during triage, had not been diagnosed with AH prior to the study. This group accounted for 8.6% of patients reporting to the Clinical Emergency Department in 2019–2020. In 55.2% of patients who had elevated BP measurements in triage and had not yet been diagnosed with AH, hypertension was confirmed by the ABPM measurement. These values are in line with the data reported in the literature cited above.

For over 40 years, the problem of diagnosing AH in EDs has been the subject of many scientific studies. In the 1970s, Kaszuba et al. [23] estimated that a large municipal ED could provide a potential screening for 24.2% of the population. Glass et al. [24] noted that in an American university hospital, less than 1/3 of patients with elevated BP values (defined as a measurement above the norm by 20 mmHg) were referred for further outpatient diagnosis. One of the first studies to assess the reproducibility of a single BP measurement in the ED was the work of Backer et al. [18]. The authors showed a high prevalence of abnormal BP values among patients in emergency care. They also indicated the repeatability of measurements during follow-up visits. A particularly high frequency of AH diagnosis among ED patients with SBP ≥ 140 mmHg or DBP ≥ 90 mmHg was demonstrated by Shiber-Ofer et al. [25]. Over the course of 30 months, out of 195 patients enrolled at the Rabin Medical Center, 147 (73%) were diagnosed with AH. The study by Shiber-Ofer et al. [25] was different from the others — the diagnosis of AH was verified by analyzing medical records, in which case, in a number of patients, the diagnosis was made using ABPM, and in others, using office measurements.

In the meta-analysis by Armitage et al. [19] of 12 studies involving 2,627 patients with high BP measured in triage, the diagnosis of AH was confirmed in 14.2% to 76.5%. It should be noted that only 2 of the 12 studies included in the meta-analysis used ABPM to confirm the diagnosis of AH, even though it seemed to be the most reliable method. None of the presented studies used ABPM as the only method of diagnosis verification. Considering the fact that office measurements are not always precise due to the existence of such phenomena as nocturnal hypertension and the "white coat effect" [26], the confirmation or exclusion of AH with ABPM may carry a lot of important clinical information and overall be more reliable [4].

In the present study 32 (55.2%) patients with elevated BP in triage were diagnosed with AH after a 24-hour ABPM. This result corresponds to that obtained in studies conducted to date in other countries.

It is vital to take into account factors influencing patients' BP. The relationship between BP values and pain has long been an object of interest to emergency physicians. Both the retrospective study conducted by Tanabe et al. [27, 28] in 2004 and the prospective study published in 2008 by the same authors did not show any correlation between pain symptoms and high BP values in triage. Also, Baumann et al. [29] did not find such a relationship when analyzing the medical records of 1,250 patients from five United States EDs. Despite the intuitive relationship between BP and pain (activation of the sympathetic system, release of catecholamines and cortisol), no statistically significant relationship was found in the current study between SBP and DBP and the level of pain assessed in visual-analogue scale.

The multicenter epidemiological study WOBASZ II conducted in Poland in 2013–2014 indicated not only high prevalence of AH in the population (42.7%), but also a significant dependence of hypertension in terms of age group [17]. Both among women and men, the percentage of patients suffering from hypertension increases significantly with age. A similar relationship was observed by Wong et al. [30] in a study analyzing the BP values among 75,342 patients admitted to the ER in four English hospitals.

According to the results of the study by Rockwood and Howlett [31] the effect of the increase in BP value with age is not observed only in the population of patients over 85 years of age. In the present study, the relationship between the age of the patients and BP measured in triage was not statistically significant — no statistically significant correlation was found between systolic rHO = 0.23; $p > 0.05$ and diastolic rHO = 0.04; $p > 0.05$ in arterial pressure and the age of the respondents. This seems to be related to the low mean age of patients (44.12 ± 14.11 years), a small representation of patients over 65 years of age (only 4 out of 58 participants) and the inclusion criterion assuming the participation of people with previously undiagnosed hypertension. Furthermore, younger patients were more willing to undergo ABPM. This may explain the low mean age in the population of this study.

In October 2021, Candel et al. [32] published the results of a multicenter cohort study that included 148,825 patients admitted to three Dutch EDs in 2017–2019. The authors did not observe statistically significant differences between SBP and DBP in men and women. These results were not consistent with Schelleman et al. [33] revealing a significant difference in the prevalence of AH between men and women. In Polish epidemiological studies, NATPOL 11 and WOBASZ II, the prevalence of AH and the values of BP measurements were significantly higher among men than women [11, 17]. This correlates with the results of this study. Significantly higher SBP (167.25 ± ± 20.87 mmHg vs. 157.57 ± 10.07 mmHg; $p < 0.05$) and DBP (98.71 ± 10.25 mmHg vs. 93.38 ± 10.4 mmHg; $p < 0.05$) was observed in male patients.

Strengths and limitations of the study

The strength of this study is its dual (retrospective and prospective) design allowing a reliable generalization of the results. The other strength is the consequent utilization of ABPM as a method of confirmation/exclusion of AH. The main limitation of the present study is relatively small (but comparable with similar studies) number of participants. An additional weakness of the study is low recruitment related with ongoing COVID-19 pandemic. Despite having 254 patients invited to the study, only 58 attended ABPM. Both modest sample size and low recruitment rate can cause substantial selection bias affecting study results.

Conclusions

In Poland, there were 239 EDs and 154 ERs, which provided emergency outpatient care to 4.6 million people in 2019 and 3.2 million people in 2020.

Performing ABPM in patients with elevated BP in triage may be helpful in the process of diagnosing hypertension. The current study revealed that 55.2% of patients with elevated BP in triage and no previous diagnosis of hypertension and require antihypertensive treatment. Furthermore, obtained data revealed the lack of correlation between BP values in the triage to the level of pain and showed a statistically significant relationship between the diagnosis of AH in ABPM and the SBP values.

Carrying out further diagnostics in ED patients with suspected hypertension may enable the introduction of AH treatment and thus protect a significant number of patients from its potentially catastrophic consequences.

Conflict of interest: None declared

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