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ORIGINAL PAPER

Impact of single-visit American versus European office blood pressure measurement procedure on individual blood pressure classification: a cross-sectional study

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Abstract

Objectives Recently, ACC/AHA and ESC/ESH guidelines defined different office blood pressure measurement (OBPM) procedures and ranges. We aimed to describe the effect of the different methods to calculate OBPM on BP classification.

Methods and results Four standardised OBPM were performed in 802 patients within a single visit. BP values were calculated (EUR-/US-BPM) and categorised (EUR-/US-Ranges) according to ACC/AHA and ESC/ESH guidelines. Comparing the BPM procedures, the mean absolute difference of systolic and diastolic BP was 4 (SD ± 5) and 3 (SD ± 3) and a difference ≥ 5 mmHg was found in 35% and 16%, respectively. There was an increase of grade 1/2 arterial hypertension of 87% and 120% comparing BP values categorised according to US-Ranges with EUR-Ranges after applying EUR- or US-BPM to all ($p < 0.0001$), of 25% and 6% comparing BP values calculated according to US-BPM with EUR-BPM applying EUR- or US-Ranges to all ($p = 0.006$ and $p = 0.17$), and of 134% comparing US-Ranges/US-BPM with EUR-Ranges/EUR-BPM ($p < 0.0001$), respectively. Overall, 16% were reclassified to higher categories when applying US-BPM, and 42–45% of patients classified as "high normal" applying EUR-BPM procedures were reclassified when applying US-BPM procedure, 76–77% of them to "hypertensive" categories.

Conclusion Besides the effect of the redefinition of BP categories by ACC/AHA, the calculation method of US-BPM compared to EUR-BPM leads to a further relevant increase of patients classified as "hypertensive". In addition to the definition of uniform outcome-oriented target BP values, there is an urgent need for a universal definition of an OBPM procedure as prerequisite for proper BP classification and patient management.

Keywords Hypertension · Blood pressure · Blood pressure determination · Epidemiology · Prevalence · Methodology

Introduction

Recently, new guidelines on arterial hypertension (AHT) were published under the lead of the American College of Cardiology/American Heart Association (ACC/AHA) and the European Society of Cardiology/European Society of Hypertension (ESC/ESH) [1, 2]. Based on office blood pressure measurements (OBPM), both guidelines defined blood pressure (BP) ranges for BP categories which are used to predict a patient's cardiovascular risk (Table 1) [1, 2]. Further, the procedure to obtain OBPM values was re-defined in both guidelines (Table 2) [1, 2]. Thus, the two guidelines differ in both the BP ranges for BP categories and the OBPM procedures. Whereas it is known that the lower ranges for BP categories by AHA/ACC will lead to a significant increase in hypertension prevalence rates, there are no data about the

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Table 1 Blood pressure categories according to ESC/ESH and ACC/AHA

Category	ESC/ESH		ACC/AHA	
	Systolic (mmHg)	Diastolic (mmHg)	Systolic (mmHg)	Diastolic (mmHg)
Optimal	< 120	< 80		
Normal	120–129	80–84	< 120	< 80
High normal/elevated	130–139	85–89	120–129	< 80
Grade 1/stage 1 hypertension	140–159	90–99	130–139	80–89
Grade 2/stage 2 hypertension	160–179	100–109	≥ 140	≥ 90
Grade 3 hypertension	≥ 180	≥ 110		

ESC/ESH European Society of Cardiology/European Society of Hypertension [2], *ACC/AHA*: American College of Cardiology/American Heart Association [1]

Table 2 Office blood pressure measurement procedure as defined in the ESC/ESH and ACC/AHA guidelines

ESC/ESH	ACC/AHA
Three BP measurements should be recorded, 1–2 min apart, and additional measurements only if the first two readings differ by > 10 mmHg. BP is recorded as the average of the last two BP readings	Use an average of ≥ 2 readings obtained on ≥ 2 occasions to estimate the individual's level of BP

ESC/ESH European Society of Cardiology/European Society of Hypertension [2], *ACC/AHA* American College of Cardiology/American Heart Association [1]

impact of different BP measurement (BPM) procedures and calculation methods on hypertension prevalence rates [3]. Therefore, our aim was to describe the impact of the new definitions of OBPM and BP ranges on AHT prevalence and individual BP classification.

Methods

For this observational cross-sectional, single-centre trial, from September 2015 to February 2016, patients at the Department of Internal Medicine and the Department of Obstetrics and Gynaecology at the University Hospital Basel (inpatient and outpatient units) were consecutively included for BPM in the context of the iPARR Trial (iPhone App compared to standard RR-measurement), as described previously [4]. The conditions for which the patients presented were not assessed. In this study, BPM were performed highly standardised in a single visit setting. Patients were sitting upright with their back supported and uncrossed legs in a quiet room. After a rest of 5 min, four standard OBPM were taken by an operator using an adequately sized upper arm cuff and an Omron-HBP-1300 device [5], each OBPM spaced 2 min apart as described previously [4]. Only patients with complete measurements were included for the present analysis.

Because four BP readings in a single visit are the minimum to meet the requirement of both guidelines (at least 3–4 readings in ESC/ESH and at least 2 BP readings in ACC/AHA guidelines), the four standardised OBPM were used to calculate BP values according to each of the two different guidelines (ESC/ESH and ACC/AHA).

To simulate the ESC/ESH BPM procedure, we checked the difference between the first two BP readings. If the difference between the first and second BPM (systolic or diastolic) was ≤ 10 mmHg, we calculated the mean of the second and third BPM, and if the difference was > 10 mmHg, we calculated the mean of the third and fourth BPM, respectively (Fig. 1). Hereafter, these values are referred to as EUR-BPM [2].

To simulate the ACC/AHA BPM, we calculated the mean of the first and the second BPM for both systolic and diastolic values (Fig. 1). These values are hereafter referred to as US-BPM [1].

In order to facilitate comparison between ACC/AHA and ESC/ESH categories, the ESC/ESH categories (Table 1) were adapted as follows: category "optimal" and "normal" were summarised to "normal" and values qualifying for "grade 3 hypertension" were included in the category of ≥ 160 and/or ≥ 100 mmHg defined as "grade 2 hypertension" (Table 3). All calculated BP values, as defined above, were then categorised once using the BP ranges of the ESC/ESH guidelines (EUR-Ranges) and once the ranges of the ACC/AHA guidelines (US-Ranges).

Statistical analysis

Continuous variables were tested for normality using boxplots. Continuous data were presented as median (interquartile range (IQR)) and compared using Wilcoxon signed

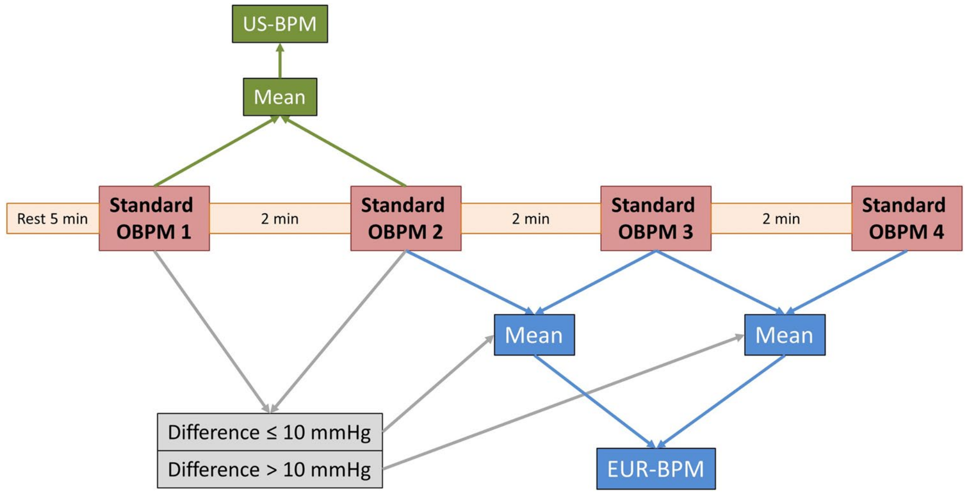

Fig. 1 Office blood pressure measurement procedure and values used to simulate ACC/AHA blood pressure (US-BPM) and ESC/ESH blood pressure (EUR-BPM) procedures. *OBPM* office blood pressure measurement

Table 3 Blood pressure categories and their blood pressure ranges used for this study

Category	EUR-Ranges		US-Ranges	
	Systolic (mmHg)	Diastolic (mmHg)	Systolic (mmHg)	Diastolic (mmHg)
Normal	< 130	< 85	< 120	< 80
High normal	130–139	85–89	120–129	< 80
Grade 1 hypertension	140–159	90–99	130–139	80–89
Grade 2 hypertension	≥ 160	≥ 100	≥ 140	≥ 90

EUR-Ranges blood pressure ranges adapted after the European Society of Cardiology/European Society of Hypertension guidelines [2], *US-Ranges* blood pressure ranges adapted after the American College of Cardiology/American Heart Association guidelines [1]

rank test, or mean (± standard deviation (SD)) and compared using Student's *t* test, as applicable. Categorical variables were presented as counts (percentages) and compared using Fisher's exact test. Agreement for continuous data was additionally analysed using Bland–Altman plots. In addition to the mean difference ± SD used for the creation of the Bland–Altman plots, we calculated the mean absolute difference between EUR-BPM and US-BPM, for which we reversed all negative numbers to positive numbers before calculation [e.g.: mean difference of − 6 and 9 = 1.5 (− 6 + 9 = 3; 3/2 = 1.5); absolute mean difference of − 6 and 9 = 7.5 (6 + 9 = 15; 15/2 = 7.5)].

To analyse the specific effect of the different BP ranges on the distribution within the predefined BP categories, we compared EUR-Ranges with US-Ranges, once after calculating BP according to EUR-BPM and once according to US-BPM, on cohort and individual levels.

To analyse the specific effect of the BPM procedures on the distribution within the predefined BP categories, we compared EUR-BPM with US-BPM, once on the basis of EUR-Ranges and once on the basis of US-Ranges, on cohort and individual levels.

To analyse the effect of both BPM procedures and BP ranges on the distribution within the predefined BP categories, we compared EUR-BPM/EUR-Ranges with US-BPM/US-Ranges on cohort and on individual levels.

To calculate the relative reclassifications between BP categories on a cohort level, we used the formula: $x = (\text{Events EUR} - \text{Events US})/\text{Events EUR}$, with "Events" referring to the numbers of patients in the specific BP category. To analyse BP reclassification on an individual level, we described the number of individual patients being reclassified within each specific analysis.

All calculations were done using SPSS version 22.

Results

1034 adult subjects were consecutively recruited. 232 patients had to be excluded due to incomplete measurements, leaving a final cohort of 802 patients. Mean age was 46.5 (IQR 32–61 years), 389 (49%) were men, and 168 (21%) were active smokers. 261 patients (33%) had a history of AHT, 88 patients (11%) of diabetes mellitus, 88 patients (11%) of coronary artery disease, 14 patients (2%) of peripheral artery disease, and 52 patients (7%) of chronic kidney disease.

There was a difference of > 10 mmHg between the first and second BPM in systolic (sBP) and diastolic BP (dBP) in 24 patients (3%), in sBP in 182 (23%), and in dBP in 36 patients (5%). Consequently, for the calculation of the EUR-BPM, we used the mean of the second and third BPM in 560 patients (70%) and the mean of the third and fourth BPM in the remaining 242 (30%) patients. In all 802 patients we used the mean of the first and second BPM for the calculation of the US-BPM.

Direct comparison of EUR-BPM and US-BPM

Median systolic EUR-BPM was 123 mmHg (IQR 113–135 mmHg) and median systolic US-BPM was 126 mmHg (IQR 115–138 mmHg) (p value < 0.0005). 28 sBP values (3%) were equal with both procedures, 567 sBP (71%) were higher, and 207 (6%) were lower when calculated as US-BPM. Median diastolic EUR-BPM was 79 mmHg (IQR 72–87 mmHg) and diastolic US-BPM 80 mmHg (73–88 mmHg) (p value < 0.0005). 56 dBP values (7%) were equal with both procedures, 475 dBP (59%) were higher, and 271 (34%) were lower when calculated as US-BPM. The mean difference between EUR-BPM and US-BPM was − 3 (SD ± 6) mmHg for sBP and − 1 (SD ± 4) mmHg for dBP; see also Fig. 2. The mean absolute difference between EUR-BPM and US-BPM was 4 (SD ± 5) mmHg for sBP and 3 (SD ± 3) mmHg for dBP. Numbers and percentage of absolute differences between EUR-BPM and US-BPM within 5, 10 and 15 mmHg are displayed in Table 4.

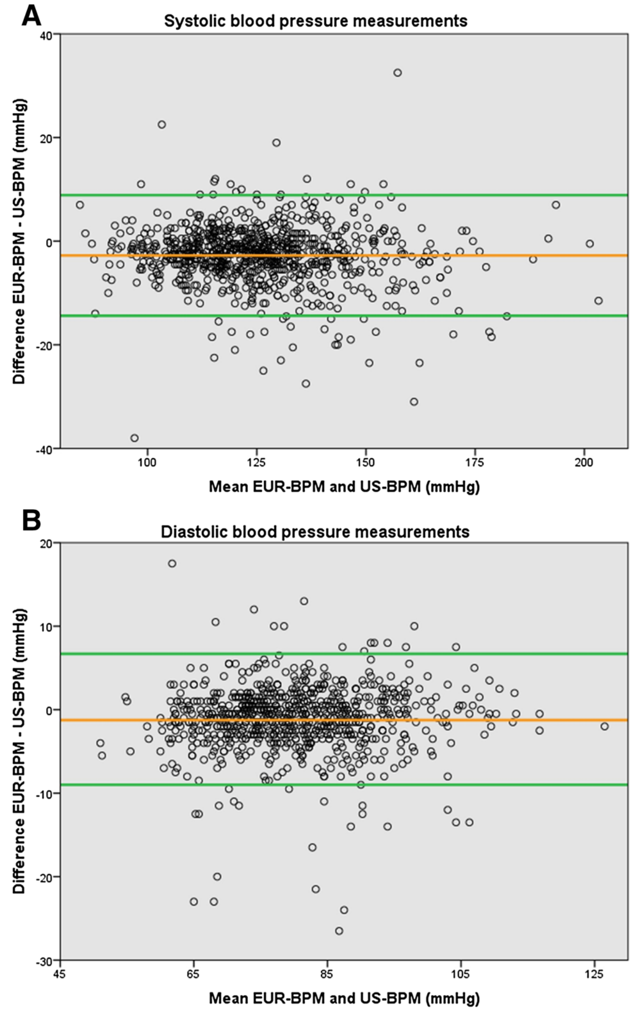

Fig. 2 Bland–Altman plots for systolic (**a**) and diastolic (**b**) blood pressure measurements. *X*-axis: mean of EUR-BPM and US-BPM, *Y*-axis: difference (EUR-BPM) – (US-BPM). Orange lines: bias; green lines: upper and lower limits of agreement (mean ± 1.96 × standard deviation). EUR-BPM: mean of 2nd and 3rd or 3rd and 4th BPM, depending on difference between 1st and 2nd BPM; US-BPM: mean of 1st and 2nd BPM

Table 4 Absolute difference between EUR-BPM and US-BPM

Absolute difference	Systolic blood pressure	Diastolic blood pressure
< 5 mmHg	524 (65%)	672 (84%)
< 10 mmHg	720 (90%)	775 (97%)
< 15 mmHg	771 (96%)	794 (99%)

Blood pressure classification on a cohort level

Impact of BP-Ranges on BP classification

Comparison of US-Ranges versus EUR-Ranges after applying EUR-BPM procedure Overall, there was an increase of 120% (n = 199/802 versus 438/802) in grade 1 and grade 2 AHT comparing BP values categorised according to US-Ranges with EUR-Ranges after applying EUR-BPM procedures to all (p value < 0.0001) (Fig. 3a).

Comparison of US-Ranges versus EUR-Ranges after applying US-BPM procedure Overall, there was an increase of 87% (n = 249/802 versus 466/802) in grade 1 and 2 AHT comparing BP values categorised according to US-Ranges with EUR-Ranges after applying US-BPM procedures to all (p value < 0.0001) (Fig. 3b).

Impact of BPM procedures on BP classification

Comparison of US-BPM with EUR-BPM procedure on the basis of EUR-Ranges Overall, there was an increase of 25% (n = 199/802 versus 249/802) in grade 1 and grade 2 AHT comparing BP values calculated according to US-BPM with EUR-BPM procedure applying EUR-Ranges to all (p value 0.0064) (Fig. 3c).

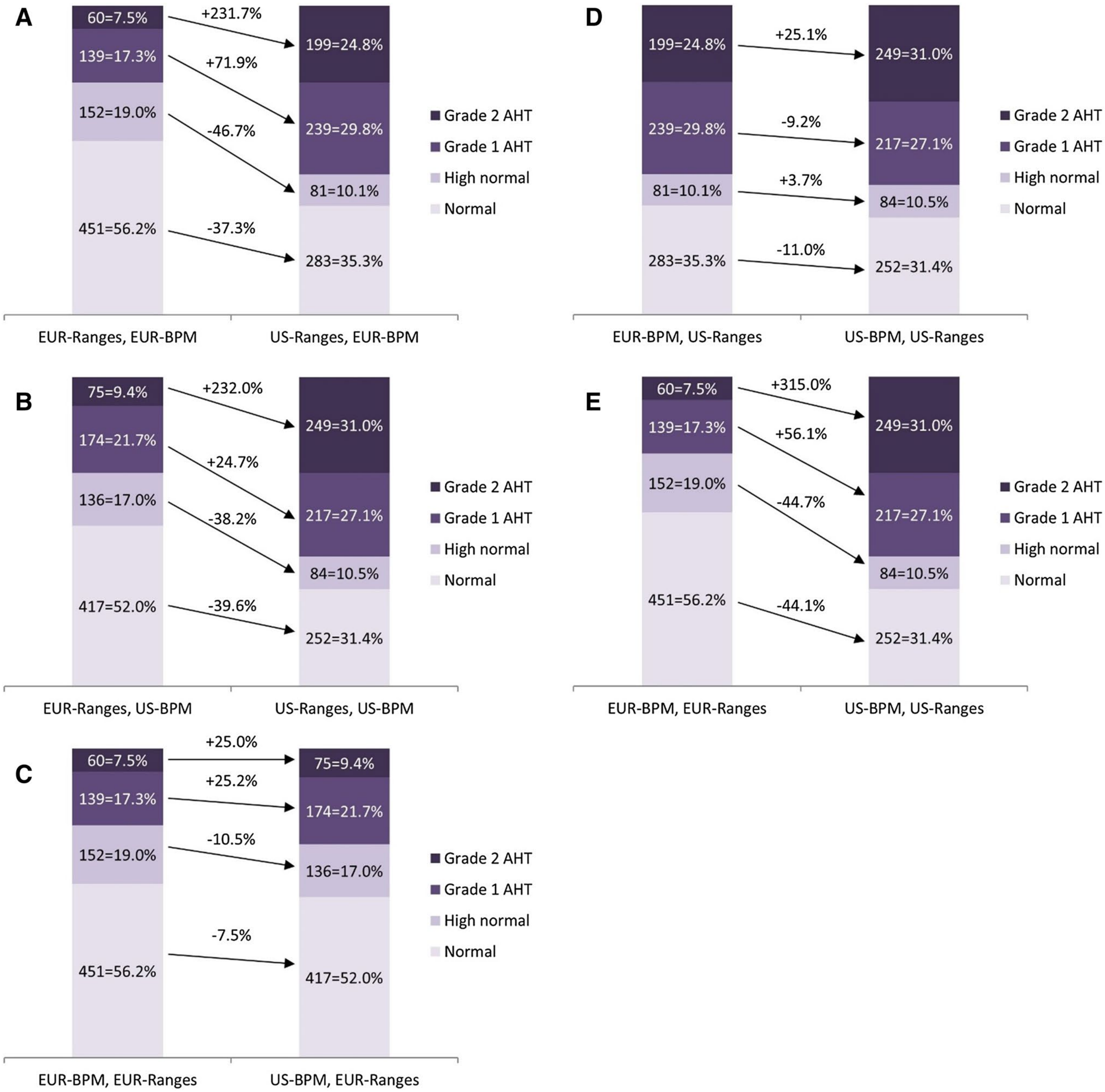

Fig. 3 Blood pressure classification on a cohort level. Impact of BP ranges alone on the basis of EUR-BPM (**a**) and US-BPM (**b**); impact of BPM procedure alone on the basis of EUR-Ranges (**c**) and US-Ranges (**d**); impact of both BPM procedure and BP ranges combined (**e**). *EUR-BPM* mean of 2nd and 3rd or 3rd and 4th BPM, depending on difference between 1st and 2nd BPM; *US-BPM* mean of 1st and 2nd BPM; *EUR-Ranges* BP categorisation according to ESC/ESH, *US-Ranges* BP categorisation according to ACC/AHA, *AHT* arterial hypertension

Comparison of US-BPM with EUR-BPM procedure on the basis of US-Ranges Overall, there was a non-significant increase of 6% ($n=438/802$ versus 466/802) in grade 1 and grade 2 AHT comparing BP values calculated according to US-BPM with EUR-BPM procedure applying US-Ranges to all (p value 0.17) (Fig. 3d).

Impact of BPM procedure and BP-Ranges on BP classification

Overall, there was an increase of 134% ($n=199/802$ versus 466/802) in grade 1 and grade 2 AHT comparing BP values calculated and categorised according to US-BPM procedure and US-Ranges with BP values calculated and categorised according to EUR-BPM procedure and EUR-Ranges, respectively (p value < 0.0001) (Fig. 3e).

Blood pressure classification on an individual level

In contrast to the above-mentioned classification on a cohort level, individuals within the same category can be classified to either higher or lower categories comparing EUR-BPM/EUR-Ranges versus US-BPM/US-Ranges.

Impact of BP-Ranges on individual BP classification

Individual BP reclassification comparing US-Ranges versus EUR-Ranges after applying EUR-BPM procedure Comparing US-Ranges versus EUR-Ranges after applying EUR-BPM procedure to all, overall 459 (57%) participants were reclassified into a higher category (Fig. 4a, red arrows). Further, 152/152 patients (100%) classified as "high normal" applying EUR-Ranges were reclassified as "hypertensive" applying US-Ranges. No patient was reclassified to lower categories (Fig. 4a).

Individual BP reclassification comparing US-Ranges versus EUR-Ranges after applying US-BPM procedure Comparing US-Ranges versus EUR-Ranges after applying US-BPM procedure to all, overall 475 (59%) patients were reclassified into a higher category (Fig. 4b, red arrows). Further, 136/136 patients (100%) classified as "high normal" applying EUR-Ranges were reclassified as "hypertensive" using US-Ranges. No patient was reclassified to lower categories (Fig. 4b).

Impact of BPM procedure on individual BP classification

Individual BP reclassification comparing US-BPM with EUR-BPM procedure on the basis of EUR-Ranges Comparing BP values calculated according to US-BPM with EUR-BPM procedure and applying EUR-Ranges to all, overall 124 patients (16%) were reclassified to higher (Fig. 4c, red arrows) and 33 patients (4%) to lower categories (Fig. 4c, blue arrows). Further, 69/152 patients (45%) classified as "high normal" applying EUR-BPM procedure were reclassified, of them 77% (53/69 patients) as "hypertensive", and 23% (16/69 patients) as "normal" applying US-BPM procedure (Fig. 4c).

Individual BP reclassification comparing US-BPM with EUR-BPM procedure on the basis of US-Ranges Comparing BP values calculated according to US-BPM with EUR-BPM procedure and applying US-Ranges to all, overall 126 patients (16%) were reclassified to higher (Fig. 4d, red arrows) and 34 patients (4%) to lower categories (Fig. 4d, blue arrows). Further, 34/81 patients (42%) classified as "high normal" applying EUR-BPM procedure were reclassified, of them 76% (26/34 patients) as "hypertensive", and 24% (8/34 patients) as "normal" applying US-BPM procedure (Fig. 4d).

Impact of BPM procedures and BP-Ranges on individual BP classification

Comparing BP values calculated and categorised according to EUR-BPM procedure and EUR-Ranges with BP values calculated and categorised according to US-BPM procedure and US-Ranges leads overall to reclassification to higher categories in 475 patients (59%) (Fig. 4e, red arrows). Further, 146/152 patients (96%) classified as "high normal" applying EUR-BPM/EUR-Ranges were reclassified as "hypertensive" applying US-BPM/US-Ranges. No patient was reclassified to lower categories (Fig. 4e).

Discussion

To the best of our knowledge, our study is the first comparing an integral part of OBPM determination, consisting of the BP calculation out of a set of highly standardised consecutive measurements as recommended by the latest guidelines. By simulating OBPM procedure and BP-Ranges of the ACC/AHA and the ESC/ESH guidelines in a single visit setting, we found large differences in BP values and categorisation in our cohort. Thus, between the two BPM procedures, the mean absolute difference of systolic and diastolic BP was 4 (SD ± 5) and 3 (SD ± 3) and a difference ≥ 5 mmHg was found in 35% and 16%, respectively. Further, there was a relevant increase in the rate of AHT when BP values were classified according to US-Ranges compared with EUR-Ranges, calculated according to US-BPM compared with EUR-BPM procedure, and classified and calculated according to US-Ranges/US-BPM compared with EUR-Ranges/EUR-BPM of 87%/120% (US-BPM/EUR-BPM), 6%/25% (US-Ranges/EUR-Ranges), and 134%, respectively. On the individual level, overall 16% were reclassified to higher categories when applying US-BPM procedure, and 42–45% of patients classified as "high normal" applying EUR-BPM procedures had to be reclassified when applying US-BPM procedure, 77% of them to "hypertensive".

AHT is the most prevalent cause of premature death worldwide [6]. An increase of sBP of 20 mmHg and dBP of 10 mmHg is associated with a doubling in the risk of death from stroke, heart disease, or other vascular disease, whereas already a seemingly minute and neglectable BP reduction of 2 mmHg translates into a risk reduction of about 10% regarding stroke mortality and about 7% regarding mortality from ischemic heart disease and other vascular causes in the

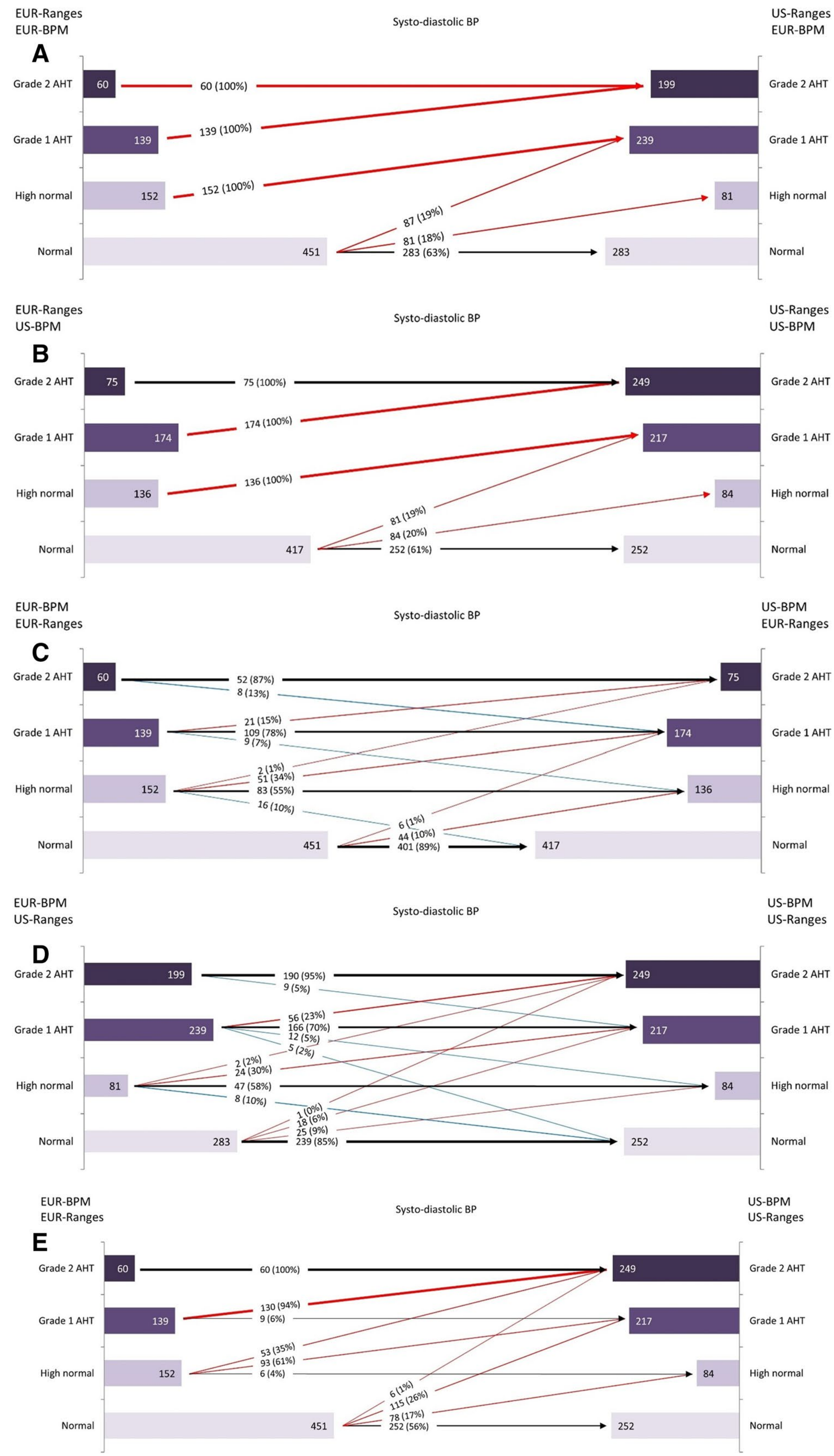

Fig. 4 Blood pressure reclassification on an individual level. Impact of BP ranges alone on the basis of EUR-BPM (**a**) and US-BPM (**b**); impact of BPM procedure alone on the basis of EUR–ranges (**c**) and US-Ranges (**d**); impact of both BPM procedure and BP ranges combined (**e**). *EUR-BPM* mean of 2nd and 3rd or 3rd and 4th BPM, depending on difference between 1st and 2nd BPM; *US-BPM* mean of 1st and 2nd BPM; *EUR-Ranges* BP categorisation according to ESC/ESH, *US-Ranges* BP categorisation according to ACC/AHA, *AHT* arterial hypertension

middle age [7]. Correspondingly, antihypertensive treatment leads to a significant reduction of the rate of stroke and coronary heart disease, as well as vascular mortality and may thus be regarded as a milestone in the history of AHT and preventive medicine [8]. However, these statements should not be translated into “the lower the better”, because to treat patients to lower BP goals may even harm patients [9]. Additionally, on an individual level, being labelled as “hypertensive” or even to have “elevated BP”, has a psychological dimension, as there are reports of an impaired quality of life [10], anxiety and distress [11] after both a correct or incorrect diagnosis of AHT. Several studies showed that absenteeism increased after patients were informed about their diagnosis of AHT [12]. Finally, for a health care system, the specific definition of AHT determines the costs of treatment on a population level [13]. Therefore, in order to correctly evaluate an individual’s cardiovascular risk, to avert harm to the patient, and to reduce health care costs, accurate assessment of BP is crucial.

The ACC/AHA guidelines recommend to categorise BP values into four levels for clinical and public health decision-making based on OBPM results [1]. The ranges stated for these categories are lower than in previous guidelines, e.g. the World Health Organization guidelines [14]. The rationale given for these BP ranges is that they better reflect the higher level of evidence of cardiovascular risk for the progressively higher BP categories [1]. They define the category of “elevated BP” as 120–129/80–84 mmHg, as there is evidence that relative risk/hazard ratio is increased already at these seemingly low BP levels [15]. Further, the ACC/AHA guidelines have not only lowered the ranges for the different BP categories, but also recommend a change in the BPM procedure without commenting on supportive data for this specific kind of OBPM [1]. To our knowledge the Systolic Hypertension in the Elderly Program (SHEP) trial is the only large trial to have applied this BPM procedure [16]. In the ACC/AHA guidelines OBPM were on one hand propagated as relatively easy to obtain with most trial experience based on “traditional” OBPM, and on the other hand the authors stress the common errors and limit the informative value of OBPM by giving out-of-office measurements a class IA recommendation for the confirmation of arterial hypertension [1]. Additionally, there are no comments in the guidelines how to deal with larger differences between the different BPM modalities [1].

The ESC/ESH guidelines remain more conservative in their BP classification and stay with the long-standing and widely accepted World Health Organisation definition [2, 14]. Additionally, the ESC/ESH guidelines have added a lower limit, below which harm exceeds the benefit [2]. Regarding OBPM procedure, they propose an entirely different approach by deciding upon the difference between the first and second BPM whether the mean between the second and third or the third and fourth BPM should be used [2]. We are not aware of any large outcome trials having applied this BPM procedure, especially not the use of the mean of a 3rd and 4th measurement when the first two measurements differ by more than 10 mmHg. Using the mean of a 2nd and 3rd measurement is quite common [17–22].

While the effect of the redefinition of BP ranges by ACC/AHA was reported after the publication of the guidelines previously [3], this is the first study comparing the effect of both BP ranges and the BPM procedures on BP classification. Especially the effect of the BPM procedure on BP classification is usually neglected but has, as we can show, a disturbingly significant effect. The substantial increase of AHT classifications over the entire cohort and the relevant number of reclassifications on an individual level due to small changes in BPM procedures would have immense consequences for both the affected patients and the health care systems. The shift into higher BP categories, in this case based on different BPM procedures, would confront many individuals with a new diagnosis of AHT, with the consequences of further diagnostic procedures, medical therapy, and monitoring of BP and therapy. Further, in a highly prevalent disorder such as hypertension already a small increase in AHT classification has relevant socioeconomic implications. Unfortunately, there are no data, which support that the BPM procedure suggested by ACC/AHA reflects the “real” BP more reliable especially with regard of the best possible assessment of the cardiovascular risk. Without those data, the extension of disease prevalence by simple modifications of the methodology entails the risk of over-diagnosis and overtreatment with potential harm for both the individual and the society.

Besides a universal definition of outcome-oriented BP ranges for the different categories, which are currently largely diverting between the ESC/ESH and the ACC/AHA guidelines, there is an absolute need for a universal definition of OBPM procedure as prerequisite for the reproducibility of studies and clinical data. Ideally, such a global standardised OBPM procedure would be able to prevent pitfalls such as white-coat hypertension and masked hypertension in most cases.

Limitations

The main limitation of our study is that we adapted the ACC/AHA BPM recommendations to a single visit. The splitting of BPM over several visits has been recommended with the intention of decreasing the number of patients with white-coat AHT to be classified as AHT. Figueiredo et al. concluded in a study comparing two–three BPM taken per visit at two different occasions that AHT was often not confirmed at reassessment, leading to an overestimation of AHT of 12.6% of true prevalence [23]. However, “true prevalence” was considered as the presence of AHT at two visits and not confirmed with ambulatory blood pressure measurements (ABPM) as it is recommended nowadays [23]. On the other hand, Verberk et al. showed in patients who had BP measured at eight visits with three BP readings per visit and compared to ABPM, that one-third of the patients consistently showed a substantial white-coat effect, defined as OPBM 20 mmHg systolic or 10 mmHg diastolic higher than home BPM or daytime ABPM, and 14% consistently had a white-coat hypertension on three or more occasions [24]. In light of this study, it seems that white-coat AHT cannot be excluded in a substantial number of patients in spite of BP readings performed in multiple visits. However most importantly, the likelihood, that a significant difference in BP values, obtained by comparing the mean of first two with the mean of the second and third/third and fourth BP readings, persists, remains very high, even if the BP values would be collected in several sessions as recommended by ACC/AHA.

Perspectives

Our study shows that minor changes in the method how to calculate OBPM can have a massive impact on AHT prevalence and individual BP classification. Unfortunately, up to now data are lacking which answer the question which OBPM procedure is the most reliable to assess the cardiovascular risk. Therefore, in addition to the definition of uniform outcome-oriented target BP values, there is an urgent need for a universal definition of a valid OBPM procedure as prerequisite for proper BP classification in clinical research and patient management [25, 26]. Until further data are available, we recommend relying on a combination with out-of office blood pressure measurement for clinical decision-making.

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Compliance with ethical standards

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

Ethical approval This trial was approved by the local ethics committee (EKNZ 2015-287), was compliant with the Declaration of Helsinki, and all patients provided written informed consent. The trial was registered on clinicaltrials.gov (NCT02552030).

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