Does the J-shaped curve for diastolic blood pressure exist?

Czy istnieje krzywa J dla rozkurczowego ciśnienia tętniczego?

Piotr Sobieraj, MD, Jacek Lewandowski, MD, PhD, Maciej Siński, MD, PhD

Department of Internal Medicine, Hypertension and Vascular Diseases, Medical University of Warsaw, Poland

INTRODUCTION

Despite advances in the pathophysiology, diagnosis and treatment of primary hypertension, it still remains the leading risk factor for cardiovascular morbidity and mortality [1–4]. The most effective way to reduce cardiovascular risk in patients with hypertension is to achieve a sustained reduction of blood pressure (BP). Currently, more scientific evidence regarding the benefits of intensive BP treatment are available, and such approach is recommended by American Heart Association (AHA) and the European Society of Cardiology (ESC) [5, 6].

Nowadays, scientific societies recommend target for systolic blood pressure (SBP) below 130 mmHg or determine its range between 130–120 mmHg [5, 6]. Recommended SBP target is the result of high-quality evidence from the clinical studies, including randomized trials and meta-analyses [5, 6].

HOW LOW IS LOW DBP?

Antihypertensive therapy aimed to achieve SBP values consistent with the current ESC guidelines results also in relatively low values of diastolic blood pressure (DBP). For example, participants of the Systolic Blood Pressure Intervention Trial (SPRINT), who after one year of participation achieved an average SBP of 121.4 mmHg had mean DBP 68.7 mmHg [7]. Patients with diabetes who took part in the Action to Control Cardiovascular Risk in Diabetes trial (ACCORD) both in the intensive (SBP 119.3 mmHg achieved after a year) and standard BP control arm (SBP 133.5 mmHg achieved after a year) had low DBP values (mean 64.4 mmHg and 70.5 mmHg, respectively) [8]. In the post-hoc analysis of the Ongoing Telmisartan Alone and in Combination with Ramipril Global Endpoint Trial (ONTARGET) and Telmisartan Randomised Assessment of Study in ACE and Intolerant participants with cardiovascular Disease trial (TRASCEND), it was shown that more than every fifth person who achieved SBP therapeutic goal of 120–130 mmHg had DBP less than 70 mmHg [9]. The presented examples show that during effective antihypertensive therapy low DBP is a frequent phenomenon and it can be a significant clinical issue in everyday medical practice. For this reason, the clinicians who apply in practice recommendations for the target SBP should be aware also of DBP reduction.

According to AHA, in the majority of patients, mainly at high and very high cardiovascular risk antihypertensive therapy should be started when BP ≥ 130/80 mmHg. The European guidelines in most patients recommend antihypertensive treatment when BP ≥ 140/90 mmHg, although hypotensive therapy should be considered in patients with coronary artery disease when BP ≥ 130/80 mmHg. The current ESC recommendations indicate,
that SBP treatment goal should be 120–130 mmHg and DBP 70–80 mmHg [6]. Therefore according to the ESC treatment range, low DBP should be defined as lower than 70 mmHg (tab. 1). In comparison, AHA guidelines suggest therapy of hypertension to achieve BP goal < 130/80 mmHg and do not indicate a lower, safe threshold for DBP [5]. The evidence supporting DBP targets is weaker than these for SBP.

show advantage of any tested treatment goal according to the clinical benefits. The probable reason for similar outcome in both groups was the small difference in DBP within groups. In the group treated to achieve DBP ≤ 90 mmHg, mean DBP was 85.2 mmHg. In group treated to reach DBP ≤ 85 mmHg participants achieved 83.2 mmHg and DBP 81.1 mmHg in the group in which authors intended to lower DBP ≤ 80 mmHg.

### Table 1. Treatment targets for patients with hypertension.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>European Society of Cardiology 2018</th>
<th>American Heart Association 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–65</td>
<td>SBP 130 mmHg (if tolerated, but not lower &lt; 120 mmHg)</td>
<td>SBP &lt; 140 mmHg (130 mmHg if tolerated)</td>
</tr>
<tr>
<td>65–79</td>
<td>SBP 130–139 mmHg (if tolerated)</td>
<td>SBP 130–139 mmHg (if tolerated)</td>
</tr>
<tr>
<td>≥ 80</td>
<td>SBP 130–139 mmHg (if tolerated)</td>
<td>SBP 130–139 mmHg (if tolerated)</td>
</tr>
<tr>
<td>DBP 70–79 mmHg</td>
<td>&lt; 80 mmHg (no target in non-institutionalized, ambulatory, community-living adults ≥ 65 years)</td>
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### J-SHAPED CURVE IN ARTERIAL HYPERTENSION

High BP values in patients with atherosclerosis were considered as a protective mechanism that ensures adequate blood flow. Therefore, high BP was not considered as an unfavourable prognostic factor. In 1957, after the publication by Dawber et al., the perception of the influence of high BP on cardiovascular events has changed. Author showed that arterial hypertension (at the time defined as ≥ 160/95 mmHg) negatively affects cardiovascular risk [10]. Interestingly, the first pioneer trials were focused mainly on DBP values and not on SBP. According to current state of knowledge, DBP values, which were verified in these studies were definitely too high. For example, at the turn of the 1960s and 1970s, it was proved that DBP decrease to values higher than 90 mmHg is beneficial as compared to DBP > 115 mmHg [11, 12]. Other studies performed at that time considered similarly high DBP as target values [13–15]. Scandinavian Hypertension Optimal Treatment study (HOT) was the one of the most important randomized trial aimed to determine target DBP [16]. Hypertensive patients were randomized to 3 groups in which antihypertensive treatment was conducted to achieve different DBP goals: ≤ 90 mmHg, ≤ 85 mmHg or ≤ 80 mmHg. The results of HOT study did not have disadvantage of any tested treatment goal according to the clinical benefits. The probable reason for similar outcome in both groups was the small difference in DBP within groups. In the group treated to achieve DBP ≤ 90 mmHg, mean DBP was 85.2 mmHg. In group treated to reach DBP ≤ 85 mmHg participants achieved 83.2 mmHg and DBP 81.1 mmHg in the group in which authors intended to lower DBP ≤ 80 mmHg.

There is lack of randomized trials performed to establish optimal on-treatment DBP target. As a result, scientific societies recommended lowering DBP to < 90 mmHg in the majority of patients [17]. Subsequent studies, which considered lower DBP values than previously tested, were post-hoc analyses of large randomized trials, which were focused on lowering SBP.

The potentially negative impact of excessive BP reduction is known as the J-shaped curve phenomenon and is mainly related to the DBP [18, 19] (fig. 1). The phenomenon has rational pathophysiological justification. Blood flow through the coronary vessels occurs during the diastolic phase of the heart cycle. For this reason, it can be expected that low DBP will result in reduced flow through the coronary vessels and lead to myocardial ischemia. Therefore, patients with lower DBP may be at higher risk for cardiovascular events. This phenomenon should be particularly easy to observe in patients with coronary heart disease, when the regulation of coronary blood flow is impaired. McEvoy et al. in the Atherosclerosis Risk in Communities study (ARIC) reported that DBP 60–69 mmHg was associated with a higher troponin concentration than DBP 80–89 mmHg [20]. In subjects with arterial hypertension, a greater increase in
troponin concentration was found among patients with DBP lower than 69 mmHg during 6 years of follow-up. It was also documented that DBP < 60 mmHg is associated with a significant reduction in myocardial perfusion pressure [21]. In the group of subjects with coronary artery disease, it was also shown that lower DBP is associated with a higher score on the SYNTAX Score scale [22]. Another study showed a relationship between DBP < 60 mmHg and concentration of troponin and inflammation parameters [23]. In addition, studies conducted in subjects with isolated systolic hypertension, show that a high pulse pressure (the difference between SBP and DBP) is related to the increased stiffness of the vessels [24]. For this reason, low DBP is a result of increased stiffness of arterial vessels what is associated with an increase in cardiovascular risk.

**DBP J-SHAPED CURVE – THE EVIDENCE**

The influence of low DBP on cardiovascular events was the aim of numerous re-analyses of randomized studies. In the Hypertension Objective Treatment Based on Measurement by Electrical Devices of Blood Pressure trial (HOMED-BP) reduction in the incidence of the composite endpoint (cardiovascular death, stroke and myocardial infarction) in patients treated to the target < 125/80 mmHg was compared with reduction of endpoints achieved with therapy to the target 125–134/80–84 mmHg [25]. The re-analysis of the Valsartan Antihypertensive Long-term Use Evaluation (VALUE) study showed that patients with DBP < 70 mmHg tolerated therapy as patients with DBP > 70 mmHg [26]. However, the authors noticed that DBP 75 mmHg is associated with the lowest cardiovascular risk. The authors of post-hoc analysis of the International Verapamil-Trandolapril Study (INVEST) showed a negative effect of DBP < 70 mmHg on the incidence of death, non-fatal myocardial infarction and non-fatal stroke [27]. The effect was less pronounced in patients after revascularization of coronary arteries [27]. Similar conclusions were found after the re-analysis of the ONTARGET study, which showed an increase in the incidence of cardiovascular death, stroke and hospitalization in patients with the lowest DBP (average 67 mmHg) [28]. Recent analysis in the merged ONTARGET and TRASCEND trials datasets presented an increased risk of cardiovascular death, stroke, stroke and hospitalization when DBP was lower than 75 mmHg [29]. Another analysis in the subgroup of ONTARGET and TRASCEND participants, who achieved SBP 120–140 mmHg, showed that DBP
< 70 mmHg is related to higher cardiovascular risk [9]. During the 21-year observation of ARIC participants, worse outcome of subjects with DBP < 70 mmHg (and in particular < 60 mmHg) was demonstrated [20]. The SPRINT study, which evaluated whether intensive blood pressure reduction (SBP < 120 mmHg) is beneficial in comparison with conventional approach (SBP < 140 mmHg), was also used to assess the effect of low DBP on cardiovascular events [7]. Among the SPRINT participants, an increased incidence of cardiovascular events has been demonstrated in participants, who achieved DBP < 60 mmHg. The effect of low DBP was nonsignificant when other cardiovascular risk factors were taken under consideration [30]. In the same population, other authors showed that DBP < 55 mmHg at single visit was an independent risk factor for cardiovascular events [31]. Also the effect of the J-shaped relationship between DBP and cardiovascular outcome was presented using the data from the Prospective Observatory Longitudinal Registry of Patients with Stable Coronary Artery Disease (CLARIFY) registry. It was found that DBP < 70 mmHg was associated with an increased risk of cardiovascular events [32]. The adverse effect of low DBP was found also in studies that included more subjects with previously diagnosed coronary artery disease. No J-shaped curve was observed in the population of the HOT study (approximately 6% cardiovascular disease), HOMED-BP (cardiovascular disease in 3%) or VALUE (> 45% coronary heart disease, > 20% stroke in the past) [16, 25, 26]. The negative impact of low DBP, however, was evident in studies that recruited a large proportion of patients with previously diagnosed coronary artery disease. No J-shaped curve was observed in the population of the HOT study (approximately 6% cardiovascular disease), HOMED-BP (cardiovascular disease in 3%) or VALUE (> 45% coronary heart disease, > 20% stroke in the past) [16, 25, 26]. The negative impact of low DBP, however, was evident in studies that recruited a large proportion of patients with previously diagnosed coronary artery disease: INVEST (100% participants with coronary artery disease), ONTARGET (75% patients with coronary artery disease) or ONTARGET-TRASCEND (48% of participants with the coronary artery disease, transient ischemic attack or stroke in 21%), CLARIFY registry (100% coronary artery disease) [9, 27–29, 32].

**DIABETES**

Patients with type 2 diabetes are at higher risk for cardiovascular events. The target value of SBP recommended for diabetic patients with hypertension is 120–130/70–80 mmHg according to ESC or according to AHA < 130/80 mmHg (tab. 1). The evidence for the benefit of lowering the SBP below 130 mmHg in population of diabetics is not evident as for non-diabetic subjects. Furthermore, data about safety/risk associated with low DBP in this group of patients is limited. Patients with diabetes constituted a minority of participants in the previously mentioned studies focused on the influence of low DBP on cardiovascular events. In the HOMED-BP study there was only 3% and in the HOT study 8% of patients with type 2 diabetes [16, 25]. In other studies, the percentage was higher: INVEST – 28%, ONTARGET – 38%, ONTARGET and TRASCEND – 37% [9, 27, 28]. Due to the heterogeneous structure of the studied population, the conclusions from these trials cannot be directly related to patients with type 2 diabetes. The ACCORD trial was the most recent randomized trial verifying significance of lower therapeutic goals for SBP in diabetic group. The hazard ratio of the composite endpoint (defined as: non-fatal infarction, non-fatal stroke, cardiovascular death) was 0.88 in the group of patients treated to SBP < 120 mmHg compared to the group treated to SBP < 140 mmHg (95% confidence interval: 0.73–1.06; p = 0.20). Such results of the trial can be explained. It is likely that the study was underpowered [8]. At the same time, there was a significant reduction in the risk of stroke in the intensive group: hazard ratio 0.59 (95% confidence interval 0.39–0.89; p = 0.01). It is worth noting, that despite low DBP values in the intensive group (DBP 64.4 mmHg achieved), incidence of cardiovascular events was similar to standard group, where DBP 70.5 mmHg was achieved. On the other hand, in the post-hoc analysis of the diabetic subpopulation of the INVEST study, it was shown that the achievement of BP 123/74 mmHg compared to 133/77 mmHg was associated with an increase in mortality by 8%, despite great reduction of SBP and small difference between on-treatment DBP in both groups [33].

Previously conducted randomized trials aimed to determine BP targets in the patients with diabetes did not refer to such low DBP values. For example, United Kingdom Diabetes Prospective Study (UKPDS) compared 2 treatment strategies: below 150/85 mmHg with below 180/105 mmHg [34]. The DBP values achieved in this study were 82 and 87 mmHg, respectively, significantly higher than the values that we can actually consider as too low. In the Appropriate Blood Pressure Control in Diabetes trial (ABCD) patients with DBP > 90 mmHg and diabetes were randomized to treatment targets DBP 75 mmHg and 80–89 mmHg. A significant 49% reduction in total mortality was demonstrated in the popula-
tion treated to reach DBP 75 mmHg target compared to less intensive therapy [35]. Similar conclusions were drawn on the basis of ABCD subpopulation analysis – in patients with diabetes, but without hypertension (BP < 140/90 mmHg). It was shown that lowering the baseline DBP by 10 mmHg reduced the risk of stroke, slowed diabetic retinopathy and progression of kidney damage [36]. Study participants achieved BP 128/75 mmHg, which was lower value than in the group of patients without antihypertensive intervention (137/81 mmHg). DBP achieved in that study cannot be considered as low according to current data. The results of these analyses do not indicate increased risk of subjects with diabetes who reached DBP of 75 mmHg.

The impact of low DBP was investigated by authors of Irbesartan Diabetic Nephropathy Trial. Study included patients with hypertension and diabetes complicated by nephropathy and 29% participants were diagnosed with prior cardiovascular disease. Increased cardiovascular risk was found in patients with DBP < 85 mmHg. The lowering DBP by 10 mmHg was associated with a 61% increase in the risk of myocardial infarction (hazard ratio 1.61, 95% confidence interval 1.28–2.02; p < 0.0001), but at the same time a 45% reduction in the risk of stroke was achieved (hazard ratio 0.45; 95% confidence interval 0.48–0.88; p = 0.005) [37]. Authors of the post-hoc analysis (Saxagliptin Assessment of Vascular Outcomes Recorded) investigated subjects with low DBP from the population of patients with diabetes mellitus (Thrombolysis in Myocardial Infarction 53 trial – SAVOR-TIMI 53). They showed that baseline DBP < 60 mmHg, in the population with diabetes and coronary artery disease, compared to DBP 80–90 mmHg was associated with an increased risk of a composite end point (death from cardiovascular causes, myocardial infarction, stroke), even after adjustment for other cardiovascular risk factors [38]. Also the analysis of the data from ONTARGET study revealed that DBP < 67 mmHg increased the risk of cardiovascular events [39].

In the management of the patient with diabetes, the effect of BP reduction should be assessed in context of both macro- and microvascular complications. Low DBP, however, was not analysed in the respect of microvascular complication in any of the studies. In the ACCORD trial, in which patients actually achieved low DBP values though the intervention was focused on SBP, intensive BP reduction (median achieved 119/64 mmHg) compared to the standard BP control (median achieved 134/71 mmHg) was associated with lower glomerular filtration rate and increased creatinine concentration. Intensive treatment in comparison with standard BP control was related to reduced frequency of macroalbuminuria [8]. In the sub-analysis of the ACCORD population with retinopathy, intensive antihypertensive treatment was not associated with a reduction in the progression of retinopathy [40].

LOW DBP IN OTHER POPULATIONS

Assessment of low DBP in populations other than discussed above is based on limited reports. In the population with isolated systolic hypertension (ISH), it should be expected that blood pressure reduction will be associated with low on-treatment DBP. ISH is defined as SBP ≥ 140 mmHg and DBP ≤ 90 mmHg [6]. The prevalence of ISH increases with age and the diagnosis is associated with a higher arterial stiffness. The SHEP study (Systolic Hypertension in the Elderly Program) analysed benefits of hypotensive therapy in the population of older subjects with ISH. An increased risk of cardiovascular events was observed in patients who achieved DBP < 70 mmHg (and in particular < 60 mmHg) [41].

In the subanalysis of the SPRINT trial, in elderly subjects aged > 75 years, intensive SBP lowering (achieved BP – 123.4/62 mmHg) in comparison of standard SBP lowering (achieved BP – 134.8/67.2 mm Hg) was related to the reduction of cardiovascular risk (hazard ratio 0.66; 95% confidence interval: 0.51–0.85) [42].

Influence of low DBP on cardiovascular risk was also analysed in patients with heart failure. In participants with heart failure with preserved ejection fraction (Treatment of Preserved Cardiac Function Heart Failure with Aldosterone Antagonist trial-TOPCAT), increased cardiovascular risk was shown in the group which achieved DBP < 60 mmHg and > 90 mmHg [43]. In another analysis of heart failure population, reduction to DBP < 68 mmHg, compared with DBP 73–76 mmHg was associated with an increased risk of cardiovascular events, also after adjustment for co-factors [44].

In the specific population of patients after heart transplantation, scientific evidence related to BP-lowering
therapy is limited. In this population it has been shown that patients with DBP < 81 mmHg are at higher risk for cardiovascular events, but this effect disappeared after considering other risk factors [45].

Data on the population with chronic kidney disease and aortic stenosis is limited.

**STROKE**

Stroke remains major complication of uncontrolled hypertension [46]. The cerebral blood flow as compared with coronary, appears to be less dependent on DBP. Significant increase in stroke risk is observed when SBP is over 115 mmHg. The reduction of stroke risk associated mainly with SBP reduction is well documented [6]. Only few analyses were carried out to investigate a relationship between low DBP and stroke risk. In the HOT study, 3 therapeutic targets for DBP (< 80 mmHg, < 85 mmHg and < 90 mmHg) showed no difference in the rate of stroke [16]. On the other hand, in the CLARIFY registry, DBP < 60 mmHg and range 60–69 mmHg were not associated with increased stroke risk as compared to DBP 70–79 mmHg. However the number of strokes was low in this analysis [32]. On the other hand, in the Clarify registry, DBP < 60 mmHg and range 60–69 mmHg were not associated with increased stroke risk as compared to DBP 70–79 mmHg. However the number of strokes was low in this analysis [32]. SPRINT post-hoc analysis showed that DBP < 70 mmHg was associated with an increased risk of stroke – hazard ratio 1.47; 95% confidence interval 1.01–2.13; p = 0.044. After adjustment for age, sex, SBP, history of cardiovascular disease and smoking, low DBP was found not to be associated with increased stroke risk [47]. The analysis performed by McEvoy in ARIC trial population did not show an increased stroke risk in subjects with low DBP [20, 48]. In the contrary, in the Rotterdam Study population, it was demonstrated that DBP < 65 mmHg was associated with a higher risk of stroke in hypertensive patients. The relationship remained significant even after adjustment for other cardiovascular risk factors [49]. Moreover the elderly population of SHEP study, active antihypertensive therapy (achieved DBP 68 mmHg) was associated with a reduced risk of stroke [48]. In the ACCORD study, in the diabetic population, allocation to the intensive treatment group (achieved DBP 64.4 mmHg) was associated with a lower stroke risk than to the standard treatment group (achieved DBP 70.5 mmHg) [8].

The majority of available scientific evidence has limited quality (most come from post-hoc analysis), although indicates, that the DBP J-shaped curve for the stroke risk do not exist. For this reason, when stroke risk is considered, antihypertensive treatment should focus on lowering SBP. On the other hand, the risk of other cardiovascular events, including myocardial ischemia, appears to be elevated in patients with coronary disease and low DBP, so reducing the SBP can be limited by achievement of too low DBP.

Differences within populations regarding the epidemiology of cardiovascular events should also be taken into consideration. Asians are at higher risk for stroke than the European population [50]. It seems that the intense lowering of SBP due to the higher risk of stroke in the Asian population may be justified, despite the increased risk of ischemic events due to the excessive reduction of DBP. Similar conclusions can be made for the post-stroke population, when the risk of subsequent stroke is bigger than the risk of the first other cardiovascular event [51].

**PREDICTIVE VALUE OF DBP**

The main limitation of the re-analyses presented above is their methodology, which excludes comparisons in groups of participants with similar characteristics. Low DBP during treatment is inseparably associated with higher age and other non-modifiable risk factor e.g. prior cardiovascular or chronic kidney disease [26, 27, 47]. It is not clear whether the higher cardiovascular risk in patients with low DBP is due to low DBP alone or significant influence of factors such as age, cardiovascular history, increased arterial stiffness or adverse effects of antihypertensive drugs. In the majority of post-hoc studies, the authors try to blunt the differences between the studied groups using various statistical techniques. The most frequently used method is the Cox proportional hazard risk model. However, this popular procedure has its limitations. The assumptions regarding the use of this Cox proportional hazard risk model are not always met and usually information on this subject is not published. No statistical model allows a fully reliable interpretation of the impact of all factors, including these we do not know. Should we reject the results of post-hoc analyses? Definitely not, but there are a few important facts to keep notice. First, low DBP is not the only predictor of cardiovascular events. The influence of other factors is very important – if they accumulate in one patient, the influence of a low DBP may be inconsiderable or irrelevant. The predictive value of DBP for cardiovascular
events was measured and is smaller than predictive value of SBP [9, 52]. Secondly, we must remember about the limitations of BP measurement. Office blood pressure measurements are not comparable to a research grade readings. To date, there are no studies regarding to the effect of low DBP measured with ABPM, which is considered to be the best method for measuring blood pressure due to best predictive value. In addition, the clinical measurement of blood pressure is only an approximation of the hemodynamic conditions in other vascular beds. A better predictor of cardiovascular events than peripheral blood pressure is central blood pressure [53]. A large discrepancy between arterial pressure values in the brachial artery and central pressure values has been reported [54]. Peripheral blood pressure measurement usually overestimate SBP and underestimate DBP in comparison to central arterial pressure. The previously described relationship between coronary flow dependence on DBP is a simplification. The coronary flow is dependent also on the other factors including the diameter of the vessel and the heart rate. In the study, the state of ischemia of the heart is also dependent on other, much more difficult to measure biological mechanisms than blood pressure. All these issues lead to the conclusion that clinical decision on antihypertensive therapy should be taken after considering other clinical factors.

SHOULD WE BE AWARE OF LOW DBP?

Negative impact of low DBP on cardiovascular events in hypertensive population comes mainly from re-analysis of randomized studies. However pathophysiological considerations already suggest that there must be BP at which it is impossible to maintain sufficient perfusion of key organs. Although the influence of low DBP on cardiovascular events is of interest for many scientists, there is no clear answer to the question of how low DBP is still safe for individual patient. The above mentioned studies show that probably DBP lower than 70 mmHg, and in particular lower than 60 mmHg, increases the cardiovascular risk. This conclusion is based mostly on the results in patients with prior cardiovascular disease.

As shown above, in many patients lowering SBP to 120–130 mmHg results in reduction of DBP below 70 or even 60 mmHg. Unfortunately, the fear of excessive DBP reduction may result in abandoning SBP target. For this reason, it is necessary to convince physicians to lower SBP to the recommended values, despite the awareness of too low DBP. In the ONTARGET and TRASCEND studies, authors suggests that the risks associated with excessive DBP depression should be optimized within the therapeutic range of SBP [9]. Concerns about low DBP values in patients who have achieved SBP target recommended in previous guidelines < 140 mmHg, cannot be the reason for resignation from further intensification of therapy aimed to obtain SBP 120–130 mmHg. In the analysis based on the SPRINT study, Beddhu et al. confirmed that low baseline DBP was related to increased incidence of cardiovascular events, but the benefit of SBP reduction < 120 mmHg compared to SBP < 140 mmHg was the same in patients with the lowest and highest DBP [55].

The answer for the question asked in the subtitle, should be based on the estimation of clinical benefit/harm ratio. This assessment, however, depends on many variables, predominantly the patient’s initial cardiovascular risk. For this reason, the idea of targeting antihypertensive treatment, on the basis of individual benefit and harm from therapy using predictive models from trials is becoming increasingly popular [56]. This approach allows the selection of blood pressure targets for each patient, however, currently there is insufficient data justifying such a treatment strategy [57, 58].

Blood pressure awareness and control has an important global importance. According to data from the NATPOL 2011 study in Poland, the effectiveness of treatment of hypertension is still insufficient. Only 26% of patients in Poland are treated effectively (to BP < 140/90 mmHg), despite a significant improvement when compared to 2002 (+12%). A slightly higher percentage of effectively treated patients is found in other European countries (approximately 32.5–38.8% achieve < 140/90 mmHg) [1, 2]. The number of effectively treated patients, when 120–130/70–80 mmHg therapeutic ranges will be implemented, will be much lower [6, 59]. Due to differences in efficacy of BP treatment in real-life conditions and in clinical trials the phenomenon of negative impact of low DBP seems to be a rare issue. From this perspective, fears of excessive reduction of DBP during antihypertensive therapy may not be a clinically significant problem in population terms. The efforts of the healthcare system should be aimed at increasing the effectiveness of antihypertensive treatment.
CONCLUSIONS
Maxim "primo non nocere" cannot justify the therapeutic inertia of the doctors when fear of low DBP withhold the effective SBP reduction. This is particularly important in the light of the results of a meta-analysis regarding antihypertensive therapy and the adverse effects of therapy cessation. Discontinuation of antihypertensive therapy is related to 89% increase of cardiovascular risk [60]. According to the current ESC guidelines physicians should target on achieving 120–130 mmHg/70–80 mmHg. The maintenance of DBP in the range 70–80 mmHg in patients who achieved SBP treatment goal should be a secondary target, especially in patients with prior cardiovascular disease.

ABSTRACT
The J-shaped curve hypothesis related to the phenomenon of increased cardiovascular risk in patients with too low blood pressure, appeared in the end of 20th century. Reduced coronary blood flow related to low diastolic blood pressure constitutes pathophysiological background of the hypothesis. Currently recommended lower on-treatment blood pressure values may result in excessive diastolic blood pressure reduction and therefore J-shaped curve should be considered during hypotensive therapy. Available evidence, mostly based on post-hoc analyses of large randomized trials, reveal unfavorable clinical effects of excessive diastolic blood pressure reduction, especially in patients with prior cardiovascular disease. In the article data regarding low diastolic blood pressure in various population of hypertensive patients were shown.

Key words: diastolic blood pressure, J curve, hypertension, therapeutic goals

STRESZCZENIE
Hipoteza krzywej J związana ze wzrostem ryzyka zdarzeń sercowo-naczyniowych także przy zbyt niskich wartościach ciśnienia tętniczego pojawia się w medycynie pod koniec XX w. Podstawę patofizjologiczną stanowi zależność przepływu wieńcowego od rozkurczowego ciśnienia tętniczego. Aktualnie zalecane niższe docelowe wartości ciśnienia tętniczego podczas leczenia nadciśnienia tętniczego (NT) mogą się wiązać z nadmierną redukcją rozkurczowego ciśnienia tętniczego, a temat krzywej J powraca jako jeden z ważniejszych w leczeniu NT.
Obecnie istnieją dowody naukowe opierające się na analizach post-hoc dużych randomizowanych badań, świadczące o niekorzystnym wpływie nadmiernej redukcji rozkurczowego ciśnienia tętniczego w szczególności w grupie osób z chorobą sercowo-naczyniową. W artykule przedstawiono dane dotyczące zbyt niskiego ciśnienia rozkurczowego w różnych populacjach chorych.

Słowa kluczowe: rozkurczowe ciśnienie tętnicze, krzywa J, nadciśnienie tętnicze, cele terapeutyczne
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P. Sobieraj, J. Lewandowski, M. Siński

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