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COMMENTARY

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An interesting link between quality of sleep and a measure of blood pressure variability

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Hypertension is associated with a high risk of mortality and morbidity due to ensuing cardiovascular and cerebrovascular events and kidney disease.[1-3] Comprehensive diagnosis and control of hypertension employing measurement of out-of-office BP as well as office BP are reportedly beneficial to prevent organ damages and better prognosis.[4-6] For example, ambulatory BP monitoring allows the acquisition of valuable information on not only the average 24-hours BP, but also the variations in the BP values that happen during the course of daily life.[7] Also, understanding the influences of certain behavioral factors on diurnal BP variation is important for the management of hypertension because alterations in diurnal BP variation due to behavioral factors are observed in many hypertensive patients.[8] Among the information obtained by ambulatory BP monitoring, previous studies have shown that BP variability is a complex phenomenon that involves both short- and long-lasting changes.

Thus, the 24-hours BP varies not only because of a reduction in BP during nighttime sleep and increase in the morning, but also because of sudden, quick, and short-lasting changes that occur both during the daytime and, to a lesser extent, at nighttime. This phenomenon, short-term BP variability, has been shown to depend on sympathetic vascular modulation and on atherosclerotic vascular changes. Several previous animal studies showed that exaggerated short-term BP variability without significant changes in mean BP induced chronic cardiovascular inflammation and remodeling. Short-term BP variability is also suggested to be clinically relevant by the fact that hypertensive patients with similar 24-h mean BP values exhibit more severe organ damage when the short-term BP variability is greater.[4,9,10]

In addition, recent clinical studies have provided epidemiological basis for supporting the greater accuracy of home BP monitoring compared with clinic pressures for prognosis of fatal and nonfatal cardiovascular disease in long-term follow-up surveys and in longitudinal studies.[11,12] There is a general consensus that home BP monitoring is more convenient, available, and less costly than ambulatory BP monitoring. Surveys of both physicians and patients suggest that home BP monitoring is both appreciated and recognized as a valuable strategy, and thus, recent international guidelines have published appeals to expand the use of home BP monitoring for routine care and to have it supported by health care systems.[1,13,14]

Although sympathovagal balance is reported to be a major determinant of BP variability in healthy patients, BP variability is also affected by atherosclerotic changes in the vascular wall in patients with cardiovascular disease. The increase in BP variability may be partly explained by the diminished baroreflex function associated with increased stiffness and reduced compliance of large elastic arteries. In this respect, BP variability has been attracting attention as a possible predictable marker for atherosclerotic disease development, progression, and long-term prognosis. Recent evidence links long-term BP variability (visit-to-visit BP variability) to the risk of cardiovascular disease, independent of mean BP levels. Potential associations between long-term BP variability and cardiovascular disease risk may be reflected in pathological alterations in arterial architecture.[15]

There were several population-based cohort studies to discuss the association between sleep quality and nighttime blood pressure and cardiovascular health.[16,17] Therefore, poor sleep quality, which

increased the night blood pressure, might have greater blood pressure variability.[18,19] Both poor sleep quality and greater BP variability increased the higher risk of cardiovascular diseases. The sleep quality might include sleep architecture, respiratory disturbance index, number of arousals, arterial oxygen saturation, and other sleep parameters including total sleep time and total sleep time. Thus, therapeutic interventions such as continuous positive airway pressure (CPAP) to reportedly succeeded in significantly reducing BP and improving BP variability in patients with obstructive sleep apnea syndrome (OSAS).[20,21]

In this issue of *The Journal of Clinical Hypertension*, *Liu X, et al* examined possible relationship between visit-to-visit BP variability and "sleep architecture" in 3,565 patients referred to an academic sleep center in a large-scale cross-sectional design.[22] The "sleep architecture" characterizes the distribution of different stages of sleep and is reportedly related to the risk of cardiovascular diseases.[23] In the present study, the authors showed that higher visit-to-visit BP variability was associated with sleep architecture as reflected by reduced REM sleep duration, thereby suggesting a possible interesting link between quality of sleep and a parameter of long-term BP variability.[22] Concerning the relevant mechanisms of the BP variability in healthy subjects, inflammation induced by sleep disturbances might be another potential pathogenic mechanism. In previous experimental and epidemiological studies, sleep disturbance was associated with higher nighttime BP though systemic inflammation.[24,25]

The potential mechanistic pathway linking visit-to-visit BP variability, an index of long-term BP variation, and sleep warrants future studies to clarify the directionality, relevant mechanisms, and therapeutic implications, as the authors claim. Furthermore, standardizing more convenient methods to calculate the visit-to-visit BP variability is essential for accurately evaluating the cardiovascular risk in hypertensive patients with and/or without sleep-related disorders including sleep apnea syndrome. Furthermore, the importance of CPAP, which might improve the sleep quality of hypertensive patients with OSAS, should be more emphasized.[26,27] Then, we need more randomized placebo-controlled study to evaluate the effect of CPAP vs placebo continuous positive airway pressure on sleep quality and BP variability in hypertensives with OSAS.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest or other disclosures concerning this manuscript.

AUTHOR CONTRIBUTIONS

Kouichi Tamura wrote the review paper. Kotaro Uchida and Tomoaki Ishigami were involved in detailed review with constructive remarks that substantially changed the review paper.

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REFERENCES

1. Umemura S, Arima H, Arima S, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). *Hypertens Res*. 2019;42:1235-1481.
2. Taguchi S, Tamura K. Afternoon blood pressure increase on home blood pressure measurement: A forgotten entity? *J Clin Hypertens (Greenwich)*. 2020;22(12):2202-2203.
3. Kario K, Park S, Chia YC, et al. 2020 Consensus summary on the management of hypertension in Asia from the HOPE Asia Network. *J Clin Hypertens (Greenwich)*. 2020;22:351-362.
4. Tamura K, Kanaoka T, Ohsawa M, et al. Emerging concept of anti-hypertensive therapy based on ambulatory blood pressure profile in chronic kidney disease. *Am J Cardiovasc Dis*. 2011;1:236-243.
5. Kario K, Tomitani N, Kanegae H, Yasui N, Nagai R, Harada H. The further development of out-of-office BP monitoring: Japan's ImPACT Program Project's achievements, impact, and direction. *J Clin Hypertens (Greenwich)*. 2019;21:344-349.
6. Bell K, Doust J, McGeechan K, et al. The potential for overdiagnosis and underdiagnosis because of blood pressure variability: a comparison of the 2017 ACC/AHA, 2018 ESC/ESH and 2019 NICE hypertension guidelines. *J Hypertens*. 2020; doi: https://doi.org/10.1097/HJH.0000000000002614. Online ahead of print. PMID: 32773652.
7. Kario K, Shin J, Chen CH, et al. Expert panel consensus recommendations for ambulatory blood pressure monitoring in Asia: The HOPE Asia Network. *J Clin Hypertens (Greenwich)*. 2019;21:1250-1283.
8. Kawano Y. Diurnal blood pressure variation and related behavioral factors. *Hypertens Res*. 2011;34:281-285.
9. Azushima K, Tamura K, Haku S, et al. Effects of the oriental herbal medicine Bofu-tsusho-san in obesity hypertension: a multicenter, randomized, parallel-group controlled trial. *Atherosclerosis*. 2015;240:297-304.
10. Azushima K, Wakui H, Uneda K, et al. Within-visit blood pressure variability and cardiovascular risk factors in hypertensive patients with non-dialysis chronic kidney disease. *Clin Exp Hypertens*. 2017;39(7):665-671.
11. Shimizu H, Hoshide S, Kanegae H, Kario K. Cardiovascular outcome and home blood pressure in relation to silent myocardial ischemia in a clinical population: The J-HOP study. *J Clin Hypertens (Greenwich)*. 2020;22(12):2214-2220.
12. Usuzaki T, Ishikuro M, Metoki H, et al. Comparison among research, home, and office blood pressure measurements for pregnant women: The TMM BirThree Cohort Study. *J Clin Hypertens (Greenwich)*. 2020;22(11):2004-2013.
13. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*. 2018;71(6):e136-e139.
14. Unger T, Borghi C, Charchar F, et al. 2020 International Society of Hypertension global hypertension practice guidelines. *J Hypertens*. 2020;38:982-1004.
15. Nwabuo CC, Yano Y, Moreira HT, et al. Long-Term Blood Pressure Variability in Young Adulthood and Coronary Artery Calcium and Carotid Intima-Media Thickness in Midlife: The CARDIA Study. *Hypertension*. 2020;76:404-409.
16. Oume M, Obayashi K, Asai Y, et al. Objective sleep quality and night-time blood pressure in the general elderly population: a cross-sectional study of the HEIJO-KYO cohort. *J Hypertens*. 2018;36:601-607.
17. Hausler N, Lisan Q, Van Sloten T, et al. Cardiovascular health and sleep disturbances in two population-based cohort studies. *Heart*. 2019;105:1500-1506.

18. Shulman R, Cohen DL, Grandner MA, et al. Sleep duration and 24-hour ambulatory blood pressure in adults not on antihypertensive medications. *J Clin Hypertens (Greenwich)*. 2018;20:1712-1720.
19. Misaka T, Niimura Y, Yoshihisa A, et al. Clinical impact of sleep-disordered breathing on very short-term blood pressure variability determined by pulse transit time. *J Hypertens*. 2020;38:1703-1711.
20. Sapina-Beltran E, Santamaria-Martos F, Benitez I, et al. Normotensive patients with obstructive sleep apnoea: changes in 24-h ambulatory blood pressure monitoring with continuous positive airway pressure treatment. *J Hypertens*. 2019;37:720-727.
21. Navarro-Soriano C, Torres G, Barbe F, et al. The HIPARCO-2 study: long-term effect of continuous positive airway pressure on blood pressure in patients with resistant hypertension: a multicenter prospective study. *J Hypertens*. 2020; doi: https://doi.org/10.1097/HJH.0000000000002664. Online ahead of print. PMID: 33239552.
22. Liu X, Logan J, Kwon Y, Lobo J, Kang H, Sohn M-W. Visit-to-visit blood pressure variability and sleep architecture. *J Clin Hypertens (Greenwich)*. 2021;23(2):323–330.
23. Ren R, Covassin N, Zhang Y, et al. Interaction Between Slow Wave Sleep and Obstructive Sleep Apnea in Prevalent Hypertension. *Hypertension*. 2020;75:516-523.
24. Meier-Ewert HK, Ridker PM, Rifai N, et al. Effect of sleep loss on C-reactive protein, an inflammatory marker of cardiovascular risk. *J Am Coll Cardiol*. 2004;43:678-683.
25. Obayashi K, Saeki K, Kurumatani N. Gender differences in the association between objective sleep quality and leukocyte count: The HEIJO-KYO cohort. *Physiol Behav*. 2016;164:19-24.
26. Loredo JS, Ancoli-Israel S, Dimsdale JE. Effect of continuous positive airway pressure vs placebo continuous positive airway pressure on sleep quality in obstructive sleep apnea. *Chest*. 1999;116:1545-1549.
27. Yang MC, Huang YC, Lan CC, Wu YK, Huang KF. Beneficial Effects of Long-Term CPAP Treatment on Sleep Quality and Blood Pressure in Adherent Subjects With Obstructive Sleep Apnea. *Respir Care*. 2015;60:1810-1818.

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