Which is more correlated with hypertensive organ damage, sleep blood pressure assessed by self-measured at home or ambulatory blood pressure monitoring?: Japan Morning Surge-Home Blood Pressure (J-HOP) Study

Sirisawat Wanthong,¹,² Tomoyuki Kabutoya,¹ Satoshi Hoshide,¹ Kazuomi Kario¹

¹Division of Cardiovascular Medicine, Department of Medicine, Jichi Medical University School of Medicine, Tochigi, Japan;
²Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

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Background

- Nighttime BP, nocturnal hypertension (nighttime ambulatory SBP ≥120 mmHg): strongest prognostic value in terms of organ damage and CVD\(^1\)

- ABPM: standard method of nighttime BP measurement

- HBPM: developed in last decade, able to measure nighttime BP

- Nighttime home and ambulatory BP had similar values and gave comparable association with LVMI, IMT and PWV\(^2\)

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\(^1\)Kario K. Essential manual of 24 hour blood pressure management: From morning to nocturnal hypertension, 2015.

Objective

To assess the associations with organ damage of nighttime SBP assessed by ABPM and HBPM

- Left ventricular mass index (LVMI)
- Carotid intima media thickness (IMT)
- Brachial ankle pulse wave velocity (baPWV)
J-HOP Study

- Japan Morning Surge-Home Blood Pressure Study
- Prospective observational study
- 75 doctors, 71 institutions (45 primary practices, 22 hospital-based OPD, 4 specialized university hospitals)

Inclusion criteria:
- HT, IGT/DM, dyslipidemia, smoker, CKD, AF, metabolic syndrome, OSA

Exclusion criteria:
- Recent (<6mo) cardiovascular or cerebrovascular events, current HD, chronic inflammatory disease, malignancy

Total participants 4,310
Methods

HBPM
2, 3, 4 a.m.
≥1 night/week
2 week
Nighttime SBP
= mean of
every value

J-HOP study: N=4310

Mon
Tue
Wed
Thu
Fri
Sat
Sun
Mon

HEM-5001;
Omron Healthcare

ABPM
22:25

TM-2421 or TM-2425; A&D Co Inc

Sleep HBPM n=2649
1005
ABPM N=1465

Nighttime SBP: from going to bed to awakening, according to participants’ diaries

Nighttime SBP = mean of every value
Methods

Left ventricular mass index (LVMI)
- 2-dimensional, M or B mode, long axis
- \( LVMI = \frac{LVM}{BSA} \)
- \( LVM = 0.8(1.04([LVIDD+PWTD+IVSTD]^3-[LIDD]^3))+0.6 \text{ g} \)
- Left ventricular hypertrophy (LVH)
  “Men >115, Women >95 g/m\(^2\)“

Mean Rt and Lt carotid intima media thickness (IMT)
- 3 points proximal to bilateral carotid bulbus at end-diastole
  “>0.9 mm”

Brachial ankle pulse wave velocity (baPWV)
- measured by volume plethysmographic method (Form PWV/ABI; Omron Healthcare)
- mean of Rt and Lt baPWV
  “≥18 m/sec”
Results

8.9±4.3 nights

Nighttime ambulatory SBP vs. Nighttime home SBP

Group 1
n=338
(33.6%)

Group 2
n=103
(10.2%)

Group 3
n=198
(19.7%)

Group 4
n=366
(36.4%)
### Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nighttime ambulatory SBP (mmHg)</td>
<td>&lt;120</td>
<td>&gt;120</td>
<td>&lt;120</td>
<td>&gt;120</td>
<td></td>
</tr>
<tr>
<td>Nighttime home SBP (mmHg)</td>
<td>&lt;120</td>
<td>&lt;120</td>
<td>&gt;120</td>
<td>&gt;120</td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>338 (34)</td>
<td>103 (10)</td>
<td>198 (20)</td>
<td>366 (36)</td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>62.0±10.8</td>
<td>60.6±9.5</td>
<td>65.4±9.9</td>
<td>63.9±11.2</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Male (%)</td>
<td>160 (47.1)</td>
<td>42 (40.8)</td>
<td>115 (58.1)</td>
<td>186 (50.7)</td>
<td>0.018*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.7±3.3</td>
<td>25.3±3.6</td>
<td>24.4±3.3</td>
<td>25.0±3.5</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>35 (10.3)</td>
<td>17 (16.5)</td>
<td>26 (13.1)</td>
<td>41 (11.2)</td>
<td>0.323</td>
</tr>
<tr>
<td>HT (%)</td>
<td>289 (85.0)</td>
<td>94 (91.3)</td>
<td>191 (96.5)</td>
<td>352 (95.9)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>DM (%)</td>
<td>55 (16.2)</td>
<td>9 (8.7)</td>
<td>50 (25.3)</td>
<td>98 (26.7)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Hyperlipidemia (%)</td>
<td>134 (39.4)</td>
<td>35 (34.0)</td>
<td>74 (37.4)</td>
<td>115 (31.3)</td>
<td>0.131</td>
</tr>
<tr>
<td>eGFR</td>
<td>74.4±16.5</td>
<td>73.2±18.7</td>
<td>72.1±17.8</td>
<td>73.2±19.8</td>
<td>0.630</td>
</tr>
<tr>
<td>Past history of Angina, AMI, Stroke (%)</td>
<td>70 (21)</td>
<td>10 (10)</td>
<td>32 (16)</td>
<td>60 (16)</td>
<td>0.072</td>
</tr>
</tbody>
</table>
Left ventricular hypertrophy

Participants were categorized based on nighttime ambulatory systolic blood pressure and nighttime home systolic blood pressure.

- **Group 1**: Nighttime ambulatory systolic BP <120 mmHg and nighttime home systolic BP <120 mmHg (n=289)
  - LVH prevalence: 91.2±23.2 g/m²

- **Group 2**: Nighttime ambulatory systolic BP ≥120 mmHg and nighttime home systolic BP <120 mmHg (n=87)
  - LVH prevalence: 93.6±21.8 g/m²

- **Group 3**: Nighttime ambulatory systolic BP <120 mmHg and nighttime home systolic BP ≥120 mmHg (n=159)
  - LVH prevalence: 100.7±25.6 g/m²

- **Group 4**: Nighttime ambulatory systolic BP and nighttime home systolic BP ≥120 mmHg (n=339)
  - LVH prevalence: 101.3±27.6 g/m²

The prevalence of LVH was significantly greater in Group 4 compared to Group 1 (p <0.001).
Carotid intima media thickness

Nighttime ambulatory systolic BP, mmHg
Nighttime home systolic BP, mmHg

Participant category based on nighttime ambulatory systolic blood pressure and nighttime home systolic blood pressure

<table>
<thead>
<tr>
<th>Group</th>
<th>Nighttime Ambulatory Systolic BP</th>
<th>Nighttime Home Systolic BP</th>
<th>Prevalence of IMT &gt;0.9 mm, %</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>&lt;120</td>
<td>&lt;120</td>
<td>0.72±0.14 mm</td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>≥120</td>
<td>&lt;120</td>
<td>0.72±0.18 mm</td>
<td>0.035</td>
</tr>
<tr>
<td>Group 3</td>
<td>&lt;120</td>
<td>≥120</td>
<td>0.79±0.15 mm</td>
<td></td>
</tr>
<tr>
<td>Group 4</td>
<td>≥120</td>
<td>≥120</td>
<td>0.80±0.19 mm</td>
<td></td>
</tr>
</tbody>
</table>
Brachial ankle pulse wave velocity

Participant category based on nighttime ambulatory systolic blood pressure and nighttime home systolic blood pressure
### Blood pressure and organ damage

<table>
<thead>
<tr>
<th></th>
<th>LVH Odds ratio (95% CI)</th>
<th>IMT &gt;0.9 mm Odds ratio (95% CI)</th>
<th>baPWV ≥18 m/sec Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model I</td>
<td>Model II</td>
<td>Model I</td>
</tr>
<tr>
<td>Nighttime ambulatory SBP ≥120 vs &lt;120 mmHg</td>
<td>1.65† (1.24-2.20)</td>
<td>1.54† (1.13-2.11)</td>
<td>1.63 (0.95-2.80)</td>
</tr>
<tr>
<td>Nighttime home SBP ≥120 vs &lt;120 mmHg</td>
<td>1.74‡ (1.29-2.34)</td>
<td>1.48* (1.06-2.06)</td>
<td>2.56† (1.41-4.64)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.95‡ (2.17-4.02)</td>
</tr>
</tbody>
</table>

Model I: unadjusted  
Model II: adjusted for age, gender, BMI, clinic SBP ≥140 mmHg

* $p<0.05$, † $p<0.01$, ‡ $p<0.001$
Participants with nocturnal hypertension (NH; nighttime home/ambulatory SBP ≥120 mmHg) had significant higher prevalence of LVH, IMT >0.9 mm and baPWV >18 m/sec.

After adjusted for covariates,

NH defined by home SBP had significant association LVH, IMT >0.9 mm and baPWV >18 m/sec

NH defined by ABPM had significant association LVH and baPWV >18 m/sec
Discussion

Nighttime home SBP and ambulatory SBP: comparable relationship with organ damage

• This study:

  - Applied nighttime home SBP of 120 mmHg as a threshold to diagnose nocturnal hypertension (NH)
  - Nighttime home SBP had better associations with organ damage than nighttime ambulatory SBP
  - HBPM readings for longer days may reflect more accurate nighttime BP values than one day ABPM reading
## Discussion

<table>
<thead>
<tr>
<th></th>
<th>Nighttime HBPM schedule</th>
<th>No. of nighttime home BP readings</th>
<th>Nighttime ABPM schedule</th>
<th>No. of nighttime ABPM readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>J-HOP</td>
<td>2, 3, 4 a.m., ≥1 day/wk, 2 wk</td>
<td>25.5±12.7 (8.9±4.3 nights)</td>
<td>every 30 min</td>
<td>14.9±2.9</td>
</tr>
<tr>
<td>Andreadis, 2016</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;, 3&lt;sup&gt;rd&lt;/sup&gt;, 4&lt;sup&gt;th&lt;/sup&gt; h after going to bed, 3 nights</td>
<td>8.5±0.9</td>
<td>every 20 min</td>
<td>19±4.7</td>
</tr>
<tr>
<td>Lindroos, 2016</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;, 3&lt;sup&gt;rd&lt;/sup&gt;, 4&lt;sup&gt;th&lt;/sup&gt; h after going to bed, 2 nights</td>
<td>5.6±1.3</td>
<td>every 20 min</td>
<td>16.6±3.5</td>
</tr>
</tbody>
</table>
Conclusion

• In participants with CV risk factors, compared to nighttime ambulatory SBP,

Nighttime home SBP was

- independently associated with LVMI, IMT and baPWV
Perspective

• Nighttime home BP monitoring
  ✓ Better association with organ damage
  ✓ Lower cost
  ✓ More easily enable to repeat measurement during long-term follow-up
  ✓ More comfortable to patients
  ✓ Could be used in clinical practice in near future
Acknowledgements

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