ABPM: Why do it and how to interpret it

Raj Padwal
Professor
General Internal Medicine and Clinical Pharmacology
Director, Hypertension Clinic
University of Alberta
Disclosures

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Speaking and Consulting Honoraria: Merck, Servier, NovoNordisk, Amgen

Chair: Canadian Hypertension Recommendations Task Force
Outline

1. Review the rationale for using ABPM.
2. Understand how to interpret ABPM.
3. Review some important procedural and technical aspects of running a monitoring program.
Burden of disease attributable to 20 leading risk factors in 2010, expressed as a percentage of global disability-adjusted life-years
## Hypertension In Canada: Latest Update

<table>
<thead>
<tr>
<th></th>
<th>Prevalence</th>
<th>Diagnosed</th>
<th>Treated</th>
<th>Controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cycle 3</strong></td>
<td>22.6</td>
<td>84.3</td>
<td>79.6</td>
<td>68.1</td>
</tr>
<tr>
<td><strong>Cycle 2</strong></td>
<td>21.8</td>
<td>82.9</td>
<td>79.1</td>
<td>64.0</td>
</tr>
<tr>
<td><strong>Cycle 1</strong></td>
<td>19.6</td>
<td>83.4</td>
<td>79.9</td>
<td>65.9</td>
</tr>
</tbody>
</table>
Some background...
BP Measurement

The measurement of blood pressure is likely the clinical procedure of greatest importance that is performed in the sloppiest manner.

– Norm Kaplan
Provider-Related Pitfalls

1. Missing auscultatory gap
2. Fast bleed rate
3. Monitor not at eye level
4. Terminal digit preference
5. Uncalibrated equipment
6. Air leaks
7. Single readings
BP measurement methods

• Office (attended, OBPM)
  – Auscultatory (mercury, aneroid)
  – Oscillometric (electronic)
• Office Automated (unattended, AOBP)
  – Oscillometric (electronic)
• Ambulatory (ABPM) – the gold standard
• Home (HBPM)

For information on blood pressure measurement devices:
• http://www.dableducational.org/sphygmomanometers.html
• http://www.bhsoc.org/bp-monitors/bp-monitors/
CHEP 2015 Recommendations

What’s new?

• Clinic blood pressures should be using electronic (oscillometric) monitors

• The diagnosis of hypertension should be based on out-of-office measurements

• The management of hypertension is all about global cardiovascular risk management and vascular protection including advice and treatment supporting smoking cessation

• Treatment of atherosclerotic renal artery stenosis is primarily medical
Out-of-office Assessment is the Preferred Means of Diagnosing Hypertension

Elevated BP Reading(s) – office, home or pharmacy

Hypertension Visit 1
History, Physical Examination and Diagnostic Tests

AOBP ≥ 135/85
OBPM ≥ 140/90

Yes

Out-of-Office Assessment
- ABPM (preferred)
- HBPM Diagnostic Series

No

BP ≥ 180/110

Hypertension

No Hypertension (Annual BP Measurement Recommended)

Clinic BP as alternate method
(If ABPM or HBPM is not available)
Example 1

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (+/- Std.Dev.)</th>
<th>Mean Dia mmHg (+/- Std.Dev.)</th>
<th>Mean HR BPM (+/- Std.Dev.)</th>
<th>BP Load Sys %</th>
<th>BP Load Dia %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>11:06-12:09 (25:03)</td>
<td>25</td>
<td>173 (14.7)</td>
<td>66 (5.5)</td>
<td>71 (10.9)</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>Awake Period</td>
<td>06:00-23:00</td>
<td>23</td>
<td>172 (14.4)</td>
<td>66 (5.5)</td>
<td>71 (10.8)</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>23:00-06:00</td>
<td>2</td>
<td>184 (19.1)</td>
<td>68 (6.4)</td>
<td>78 (13.4)</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Asleep Dip: Sys = -6.6% Dia = -4.3%</td>
<td></td>
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</tbody>
</table>
Example 1

At minimum, 21 daytime and 7 nighttime readings are required.

The percentage of successful readings should be 70% or higher.
ABPM: Number of Readings

• Recommendation is at least 21 readings in the daytime and 7 at night. A ≥70% reading capture success rate should be present.

• Minimum number is 2 per hour. In our clinic, we do readings every 20 minutes in the daytime and every 30 minutes at night.
Summary of ABPM Interpretation

1. Check for technical adequacy (number of readings; percent reading capture).
Example 2

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (± Std.Dev.)</th>
<th>Mean Dia mmHg (± Std.Dev.)</th>
<th>Mean HR BPM (± Std.Dev.)</th>
<th>BP Load Sys %</th>
<th>BP Load Dia %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>09:32-09:47 (24:15)</td>
<td>41</td>
<td>128 (17.8)</td>
<td>76 (8.7)</td>
<td>65 (8.4)</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Awake Period</td>
<td>09:00-22:30</td>
<td>29</td>
<td>133 (18.3)</td>
<td>79 (7.4)</td>
<td>67 (9.0)</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>22:30-09:00</td>
<td>12</td>
<td>118 (11.3)</td>
<td>68 (6.0)</td>
<td>59 (1.9)</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Asleep Dip:</td>
<td>Sys = 11.5%</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Dia = 14.5%</td>
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<td></td>
</tr>
</tbody>
</table>
Normal BP. Spike at 14:00 was after moderate exercise.

Patients are asked not to exercise during the study period.
Summary of ABPM Interpretation

1. Check for technical adequacy (number of readings; percent reading capture).

2. Check the diary (to define daytime/nighttime; need to exclude exercise; medication times, etc)
Some more background...

Rationale for ABPM use
Prognostic Significance of Clinic vs. ABPM

Dawes. BP Monit 2006
Prognostic Significance of Clinic vs. ABPM

Dawes. BP Monit 2006
White Coat and Masked Hypertension

\[
\begin{array}{|c|c|}
\hline
\text{Office SBP mmHg} & \text{Home/Ambulatory SBP mmHg} \\
\hline
100 & 100 \\
120 & 120 \\
140 & 140 \\
160 & 160 \\
180 & 180 \\
200 & 200 \\
\hline
\end{array}
\]

- Masked Hypertension
- Hypertension
- Normotension
- White Coat Hypertension

Derived from Pickering et al. Hypertension 2002: 40: 795-796
Prevalence of masked hypertension is approximately 10% in the general population but is higher in patients with diabetes.
ABPM vs. Clinic BP Guided Rx

Staessen et al. JAMA 1997
Cost-Effectiveness of ABPM

Lovibond. Lancet 2011
Example 3

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (+/- Std.Dev.)</th>
<th>Mean Dia mmHg (+/- Std.Dev.)</th>
<th>Mean HR BPM (+/- Std.Dev.)</th>
<th>BP Load Sys %</th>
<th>BP Load Dia %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>14:22-13:34 (23:12)</td>
<td>52</td>
<td>113 (13.1)</td>
<td>68 (10.2)</td>
<td>63 (7.7)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Awake Period</td>
<td>07:00-00:30</td>
<td>38</td>
<td>119 (8.7)</td>
<td>72 (7.0)</td>
<td>66 (7.4)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>00:30-07:00</td>
<td>14</td>
<td>96 (7.5)</td>
<td>55 (6.1)</td>
<td>57 (3.5)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asleep Dip: Sys</td>
<td>19.0%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Dia 23.8%</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example 3

Normal study
Clinic, Home, Ambulatory (ABP) Blood Pressure Measurement Equivalence Numbers

A clinic blood pressure of 140/90 mmHg has a similar risk of a:

<table>
<thead>
<tr>
<th>Description</th>
<th>Blood Pressure mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home pressure average</td>
<td>135 / 85</td>
</tr>
<tr>
<td>Daytime average ABP</td>
<td>135 / 85</td>
</tr>
<tr>
<td>24-hour average ABP</td>
<td>130 / 80</td>
</tr>
</tbody>
</table>

10-20% dipping from daytime average to nighttime average is considered normal
Summary of ABPM Interpretation

1. Check for technical adequacy (number of readings; percent reading capture).
2. Check the diary (to define daytime/nighttime; need to exclude exercise; medication times)
3. Check overall, daytime, nighttime thresholds for high blood pressure.
Example 4

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (+/- Std.Dev.)</th>
<th>Mean Dia mmHg (+/- Std.Dev.)</th>
<th>Mean HR BPM (+/- Std.Dev.)</th>
<th>BP Load Sys %</th>
<th>BP Load Dia %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>09:16-08:14 (22:58)</td>
<td>61</td>
<td>119 (16.9)</td>
<td>73 (10.1)</td>
<td>65 (7.0)</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Awake Period</td>
<td>05:00-20:00</td>
<td>41</td>
<td>124 (17.7)</td>
<td>75 (10.1)</td>
<td>67 (7.6)</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>20:00-05:00</td>
<td>20</td>
<td>110 (10.9)</td>
<td>68 (7.9)</td>
<td>63 (5.0)</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>Asleep Dip:</td>
<td>Sys = 10.7%</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dia = 10.3%</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Normal. Likely has reactive hypertension.
Example 5

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (+/- Std.Dev.)</th>
<th>Mean Dia mmHg (+/- Std.Dev.)</th>
<th>Mean HR BPM (+/- Std.Dev.)</th>
<th>BP Load Sys</th>
<th>BP Load Dia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>15:18-14:29 (23:11)</td>
<td>39</td>
<td>151 (22.6)</td>
<td>96 (12.8)</td>
<td>77 (12.2)</td>
<td>77</td>
<td>85</td>
</tr>
<tr>
<td>Awake Period</td>
<td>07:00-00:00</td>
<td>31</td>
<td>152 (24.2)</td>
<td>96 (13.4)</td>
<td>78 (12.2)</td>
<td>71</td>
<td>81</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>00:00-07:00</td>
<td>8</td>
<td>148 (15.9)</td>
<td>93 (10.5)</td>
<td>71 (10.8)</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Asleep Dip: Sys = 3.1%  Dia = 3.3%
Example 5

Systolic diastolic hypertension. Non-dipper.
Predictive Role of Nighttime BP

**Total mortality**
- Nighttime (+10 mm Hg): 1.14 (1.08 - 1.20)
- Daytime (+10 mm Hg): 0.96 (0.91 - 1.02)
- Night-to-day ratio (+0.1): 1.15 (1.08 - 1.24)
- Nondipping (0.1): 1.22 (1.07 - 1.39)

**Cardiovascular events**
- Nighttime (+10 mm Hg): 1.15 (1.09 - 1.21)
- Daytime (+10 mm Hg): 1.09 (1.03 - 1.16)
- Night-to-day ratio (+0.1): 1.08 (1.01 - 1.16)
- Nondipping (0.1): 1.15 (1.00 - 1.33)

Hansen. Hypertension 2012
Dipping Status

• Dipper (normal): 10-20% dipping between the daytime to the nighttime average

• Non-dipper: <10% dipping

• Reverse dipper: rise in BP at night

• Extreme dipper: >20% dipping
Summary of ABPM Interpretation

1. Check for technical adequacy (number of readings; percent reading capture).
2. Check the diary (to define daytime/nighttime; need to exclude exercise; medication times)
3. Check overall, daytime, nighttime thresholds for high blood pressure.
4. Check dipping status (optional – some dose antihypertensives at hs to rectify nocturnal non-dipping BUT this is not a guideline concordant practice.)
Other Indications for ABPM
ABPM Indications

THE MAJOR INDICATION: TO MAKE THE DIAGNOSIS OF HYPERTENSION

Table 1. Clinical Indications for Ambulatory Blood Pressure Monitoring

To rule out suspected office hypertension (ie, white-coat hypertension)
To evaluate borderline hypertension with end-organ damage
To investigate labile/paroxysmal hypertension
To evaluate symptoms possibly related to blood pressure fluctuations (especially orthostasis)
To evaluate orthostatic hypotension, autonomic neuropathy, and carotid sinus syncope
To follow up adequacy of antihypertensive therapy

Chughtai and Peixoto. Hosp Phys 2003
Information Provided by ABPM

1. Estimate of true overall 24 hour BP
   - not affected by observer bias
   - detects masked and white coat effect

2. Circadian variation in BP

3. Variability in BP

4. Duration of action of drug
Contraindications or Barriers to ABPM

1. Not cooperative

2. Severe office HTN (≈220/120)

3. Arm too big (above 48-50 cm)

4. Severe PVD or thrombocytopenia
Example 5

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (+/- Std.Dev.)</th>
<th>Mean Dia mmHg (+/- Std.Dev.)</th>
<th>Mean HR BPM (+/- Std.Dev.)</th>
<th>BP Load Sys %</th>
<th>BP Load Dia %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>13:26-12:07 (22:41)</td>
<td>48</td>
<td>152 (16.3)</td>
<td>65 (8.8)</td>
<td>61 (3.2)</td>
<td>98</td>
<td>6</td>
</tr>
<tr>
<td>Awake Period</td>
<td>07:30-23:00</td>
<td>32</td>
<td>157 (11.6)</td>
<td>67 (6.7)</td>
<td>61 (3.8)</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>23:00-07:30</td>
<td>16</td>
<td>142 (19.7)</td>
<td>59 (10.0)</td>
<td>61 (1.8)</td>
<td>94</td>
<td>12</td>
</tr>
</tbody>
</table>

Asleep Dip: Sys = 9.6%  Dia = 12.3%
Example 5

Isolated systolic hypertension.

(What if this patient was over 80 years?)
Example 7

<table>
<thead>
<tr>
<th>Period</th>
<th>Time</th>
<th>Samples</th>
<th>Mean Sys mmHg (+/- Std.Dev.)</th>
<th>Mean Dia mmHg (+/- Std.Dev.)</th>
<th>Mean HR BPM (+/- Std.Dev.)</th>
<th>BP Load Sys %</th>
<th>BP Load Dia %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>13:33-13:08 (23:35)</td>
<td>61</td>
<td>152 (15.8)</td>
<td>101 (9.6)</td>
<td>99 (15.5)</td>
<td>97</td>
<td>100</td>
</tr>
<tr>
<td>Awake Period</td>
<td>07:30-21:30</td>
<td>39</td>
<td>156 (16.2)</td>
<td>106 (9.1)</td>
<td>107 (14.3)</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>Asleep Period</td>
<td>21:30-07:30</td>
<td>22</td>
<td>145 (12.8)</td>
<td>94 (4.0)</td>
<td>86 (5.5)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Asleep Dip:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Sys = 7.1%</td>
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<tr>
<td>Dia = 11.5%</td>
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</tr>
</tbody>
</table>

mmHg-bpm
Example 7

Systolic/diastolic hypertension. Tachcardia. Negative chronotropic agent such as beta-blocker or non-DHP CCB would be of use.
Example 9

Autonomic failure in Parkinson’s Disease

Ziemmsen. J Neurol Sci 2010
Reading ABPM: Summary

• Check for a valid number of readings and sleep/awake time
• Check the overall BP, daytime BP and nighttime BP to ensure targets are met
• Check dipping status (may wish to dose a drug at bedtime if non-dipper)
• Check HR and adequacy of control (because it might affect choice of next drug)
Practical Considerations

• Use the non-dominant arm unless the dominant arm has 10 mmHg or greater BP compared to the non-dominant arm.
• Have the patient keep a diary.
• Adjust the settings to correspond to bedtime and time awake.
• Ask them to stop and stand still when a reading is being taken (if possible).
• Go about their daily routine but ask them not to exercise.
• Test an initial reading to be sure it’s working.
• Use a proper sized cuff.
• A thin sleeve over the arm and under the monitor helps prevent bruising.
hypertension.ca

• For patients:
  • free access to the latest information and resources

• For professionals:
  • Access an accredited 15.5 hour interdisciplinary training program
  • Sign up for free monthly news updates, featured research and educational resources
  • Become a member for special privileges and savings