Role of 24-hour ambulatory blood pressure monitoring in diagnosis and management of hypertension

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Division of Nephrology, University of Ottawa
No conflict of interest
Objectives

Recognize that hypertension (HTN) is highly prevalent and has adverse vascular outcomes

Understand the utilization of 24-hour ambulatory BP monitoring (ABPM) for diagnosis and management of HTN in Canada

Explain the deficiencies of office BP measurements versus advantages of 24-hour ABPM with regards to diagnosis and management of HTN

Discuss the relevance of 24-hour ABPM for diagnosis and management of White-coat HTN, Masked HTN, and impaired Nocturnal patterns of BP
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Prevalence of Hypertension
Age-specific prevalence and incidence of diagnosed hypertension among adults aged 20 years and older in 2007/08, by sex.

Overall Prevalence of HTN in Canada in Adults 20 Years of Age and Older is 23%
Age-specific prevalence and incidence of diagnosed hypertension among adults aged 20 years and older in 2007/08, by sex.

Cynthia Robitaille et al. CMAJ 2012;184:E49-E56
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ASSOCIATION OF SYSTOLIC BP AND CARDIOVASCULAR DEATH

Stamler J et al. Diabetes Care 1993
Blood Pressure and Mortality from Stroke

A: Systolic blood pressure

B: Diastolic blood pressure

Usual systolic blood pressure (mm Hg)

Usual diastolic blood pressure (mm Hg)
Blood Pressure and Mortality from Ischemic Heart Disease

A: Systolic blood pressure

B: Diastolic blood pressure
Age-adjusted Risk for ESRD stratified by BP

Age-adjusted ESRD rates per 100,000 person-years

- <120/80 mmHg
- 120-129/80-84 mmHg
- 130-139/85-89 mmHg
- 140-159/90-99 mmHg
- 160-179/100-109 mmHg
- 180-209/110-119 mmHg
- ≥210/120 mmHg

High blood pressure is the single most important modifiable risk factor for cardiovascular mortality and morbidity.
High blood pressure is the single most important **modifiable** risk factor for cardiovascular mortality and morbidity.
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Accurate assessment of patient’s true BP load is crucially important for the diagnosis and management of hypertension.
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Accurate assessment of patient’s true BP load is crucially important for the diagnosis and management of hypertension.

Which blood pressure readings should we use for diagnosis and management of HTN?
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Techniques recommended by CHEP to measure BP for diagnosis and management of HTN

<table>
<thead>
<tr>
<th>BP measurement Method</th>
<th>Diagnosis</th>
<th>Follow-up</th>
</tr>
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<tbody>
<tr>
<td>Manual (mercury/aneroid)</td>
<td>Not recommended</td>
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</tr>
<tr>
<td>Automated Oscillometric Device</td>
<td>Not recommended</td>
<td>1st choice</td>
</tr>
<tr>
<td>Pharmacy BP</td>
<td>Not recommended</td>
<td>2nd choice</td>
</tr>
<tr>
<td>24-hr ABPM</td>
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<td>Specific situations</td>
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And do we follow these recommendations...?
How do family physicians measure BP in clinical practice?

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<td>36.2%</td>
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*Kaczorowski et al. Can Fam Physician 2017;63:193-199*
How do family physicians measure BP in clinical practice?

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24-hour ABPM is underutilized for diagnosis (and management) of HTN in Canada.

Is that a problem?
Objectives

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Explain the deficiencies of office BP measurements versus advantages of 24-hour ABPM with regards to diagnosis and management of HTN

Discuss the relevance of 24-hour ABPM for diagnosis and management of White-coat HTN, Masked HTN, Labile HTN, and impaired Nocturnal patterns of BP
Major disadvantages of office BP assessment

BP is taken under circumstances that may adversely affect the level of BP (overestimate - white-coat effect or underestimate – masked HTN, true BP)

It does not provide any information about nocturnal BP
Advantages of 24-hour ABPM

24-hour ABPM provides a profile of BP away from the medical environment, thereby allowing identification of individuals with a white-coat response or masked hypertension.
DIURNAL RHYTHM OF BLOOD PRESSURE
(normotensive patient with normal nocturnal BP and dipping pattern)

- Systolic: 125±8 mmHg during daily activities/work, 113±6 mmHg during sleep
- Diastolic: 74±7 mmHg during daily activities/work, 62±6 mmHg during sleep

(time of the day (hours))

- Daily activities/work: 9-19
- Sleep: 21-7
White Coat Hypertension/White Coat Effect
Patterns of BP related to white-coat window

White-coat hypertension

definition – in patients naïve to hypertension therapy, office BP above 140/90 mmHg, whereas daytime average BP by 24-hour ABPM is <135/85 mmHg

White-coat effect

definition – in patients with confirmed sustained HTN, office BP readings higher (by at least 10 mmHg) compared to BP readings outside office
<table>
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<th>ABPM ≥135/85</th>
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<tr>
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<td>MASKED HTN</td>
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**WHITE-COAT HTN AND EFFECT**
58 y old male

Ref: Difficult to control HTN/Secondary HTN?

Hx of HTN 2 years

No Hx of IHD/Stroke/DM/CKD

Meds Amlodipine 10 mg/day, Perindopril 4 mg/day, Bisoprolol 5 mg/day, HCTZ 25 mg/day

Non smoker/Not excessive alcohol intake/Treadmill 4x/wk

BMI 22

Office BPs    casual    resting    standing
1. Visit      175/88    156/77    169/87
2. Visit      167/86    157/82    164/81

Labs: Scr 78/ACR N/ECG N

Home BP readings 115-140/65-85
24-hour ABPM

Systolic 124±9 mmHg
Diastolic 72±7 mmHg

Systolic 110±6 mmHg
Diastolic 62±6 mmHg

Dg: White coat effect. Normal BP during the day and sleep. Dipper.
White-coat HTN – Clinical Relevance

These two patterns are highly prevalent (20-40%), in particular in elderly and very elderly patients. For example, post-hoc analysis of HYVET showed high prevalence of white-coat HTN (about 50%) among very elderly. (Bulpitt et al. Hypertension 2013;61:1-6)
White-coat HTN – Clinical Relevance

These two patterns, white-coat HTN and white-coat effect clearly represent situation where treatment based solely on office BP readings will lead to “unnecessary” drug therapy or to overtreatment.
Patients with white-coat hypertension do require close follow-up (preferably with 24-hour ABPM or home BP monitoring) as they have higher risk of developing hypertension in the future and higher risk of adverse cardiovascular events.

(Huang et al. J Hypertens 2017;35:677-688)
White-coat HTN – Treat or Not to treat?

There are no RCTs to assess benefits of BP lowering therapy in patients with untreated white-coat HTN.
Masked HTN
Masked Hypertension

Other terms used: reversed white coat hypertension, white coat normotension, work-related hypertension.

Definition of Masked HTN - patients naïve to BP lowering therapy classified as normotensive by office BP measurements that are hypertensive by 24-hour ABPM.

Definition of Masked Uncontrolled HTN – treated patients with sustained HTN with controlled office BP, but daytime average BP on 24-hour ABPM >135/85 mmHg (difference of at least 10 mmHg).
<table>
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<td>&lt;140/90</td>
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<tr>
<td>ABPM ≥135/85</td>
<td><strong>MASKED HTN</strong></td>
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Masked Hypertension

**Prevalence** is high (20-40% among hypertensive patients)  
*Franklin et al. Hypertension 2015;65:16-20.*

**Diagnostic method** – 24-hour ABPM and to limited extent self home BP monitoring (does not provide information on nocturnal BP).
48 y old male

Ref: HTN and MAU

Hx of HTN 10 years

No Hx of IHD/Stroke/

DM type 2 x 5 years/N Scr/ACR 55

Meds HCTZ 25 mg/day, Trandolapril 4 mg/day, Amlodipine 10 mg/day

Ex-smoker/No alcohol/Golf summer/Skiing winter

BMI 26

Office BPs     casual     resting     standing
1. Visit  155/79     131/77     150/87

Labs: Scr 90/ACR 47.4/Echocardiogram LVH

Home BP readings 140-155/80-90
Dg: Systolic and Diastolic HTN during day. Normal BP during sleep. Extreme Dipper.

Recommendation: Masked HTN. Titrate BP therapy to target BP.
Masked Hypertension

DO PATIENTS WITH “MASKED HYPERTENSION” SHOW MORE EXTENSIVE TARGET ORGAN DAMAGE THAN TRUE NORMOTENSIVE SUBJECTS?
LEFT VENTRICULAR MASS IN PATIENTS WITH MASKED HYPERTENSION

* p<0.05 vs true normotensive

Sega et al. Circulation 2001;104:1385-1392
CAROTID ATHEROSCLEROSIS IN PATIENTS WITH MASKED HYPERTENSION

* p<0.05 vs true normotensive

Sega et al. Circulation 2001;104:1385-1392
Masked Hypertension

ARE PATIENTS WITH “MASKED HYPERTENSION” AT INCREASED RISK OF CARDIOVASCULAR AND CEREBROVASCULAR MORBIDITY/MORTALITY?
PROGNOSIS OF MASKED HYPERTENSION

1332 subjects in Japan, 24-hr ABPM and office BP, cardiovascular mortality and cerebrovascular morbidity over 10 year F/U

True hypertensive (office BP >140/90, daytime ABPM >135/85)

Masked HTN (office BP <140/90, daytime ABPM >135/85)

True normotensive (office BP <140/90, daytime ABPM <135/85)

10-year cardiovascular mortality and cerebrovascular morbidity (RR and 95% CI)

Major disadvantages of office BP assessment

BP is taken under circumstances that may adversely affect the level of BP (overestimate - white-coat effect or underestimate – masked HTN, true BP)

It does not provide any information about nocturnal BP
Advantages of ABPM

24-hour ABPM can demonstrate a number of patterns of BP behaviour that are relevant to clinical practice, such as nocturnal hypertension and nocturnal pattern of BP (dipping, non-dipping, reverse-dipping, extreme dipping).
Nocturnal (nighttime) window

daytime window

nighttime window

white-coat window

vesperal window

matinal window

time of the day (hours)
Abnormal patterns of nocturnal BP

Nocturnal hypertension

Non-dipping

Reverse dipping

Extreme dipping

Morning BP surge
DIURNAL RHYTHM OF BLOOD PRESSURE
(normotensive patient with normal nocturnal BP and dipping pattern)

Systolic 125±8 mmHg
Diastolic 74±7 mmHg

Systolic 113±6 mmHg
Diastolic 62±6 mmHg

time of the day (hours)
daily activities/work
sleep
Patterns of BP related to nocturnal window

Nocturnal hypertension

**definition** – blood pressure during sleep > 120/70 mmHg

**prognosis** – strongest predictor of adverse cardiovascular outcomes

(Hansen et al. Hypertension 2011;57:3-10).
(Salles et al. Hypertension 2016;67:693-700).
24-hr ABPM
(systolic daytime HTN, nocturnal systolic HTN, dipper)

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<tr>
<th>Time of the Day (hours)</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
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<tbody>
<tr>
<td>Daily activities/work</td>
<td>157±15 mmHg</td>
<td>75±11 mmHg</td>
</tr>
<tr>
<td>Sleep</td>
<td>139±10 mmHg</td>
<td>62±8 mmHg</td>
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- Systolic 157±15 mmHg
- Diastolic 75±11 mmHg
- Systolic 139±10 mmHg
- Diastolic 62±8 mmHg
Patterns of BP related to nocturnal window

Non-dipping

definition – absence of decrease in nighttime BP by 10% or more

prognosis – higher risk (compared to dippers) of adverse cardiovascular events 1.40 (95% CI 1.227-1.597)

(Salles et al. Hypertension 2016;67:693-700).
24-hour ABPM
(normal daytime BP, nocturnal systolic HTN, non-dipper)

**Systolic**
- During daily activities/work: 125±8 mmHg
- During sleep: 126±8 mmHg

**Diastolic**
- During daily activities/work: 74±7 mmHg
- During sleep: 68±6 mmHg
Patterns of BP related to nocturnal window

Reverse dipping

**definition** - BP rises above daytime pressures rather than falling during the night

**prognosis** – increased risk of stroke and cardiac events

1.785 (95% CI 1.47-2.15)

*(Salles et al. Hypertension 2016;67:693-700).*
DIURNAL RHYTHM OF BLOOD PRESSURE
(normal daytime BP, nocturnal HTN, reverse dipper)

Systolic 133±11 mmHg
Diastolic 71±9 mmHg
daytime

Systolic 151±9 mmHg
Diastolic 82±8 mmHg
sleep

(time of the day (hours))
Patterns of BP related to nocturnal window

Extreme dipping and Morning surge in BP

definition - a marked nocturnal fall in BP (> 20%)

Extreme dipping is closely associated with an excessive (>55 mmHg for SBP) morning surge in BP
Dg: Systolic and Diastolic HTN during day. Normal BP during sleep. Extreme Dipper with Excessive Morning BP Surge.
Extreme Dipper (≥50 mmHg) and Morning SBP Surge (≥60 mmHg).

Dg: Systolic and Diastolic HTN during day. Normal BP during sleep. Extreme Dipper with Excessive Morning Surge.
Patterns of BP related to nocturnal window

Extreme dipping and Morning surge in BP

prognosis - patients with atherosclerotic disease are at risk of nonfatal ischaemic stroke and myocardial ischemia, an excessive (>55 mmHg) morning surge in SBP is associated with an increase in risk for stroke and acute coronary event 1.203 (95% CI 0.821-1.763)

(Salles et al. Hypertension 2016;67:693-700).
Conclusions

Given the limitations of office blood pressure assessment, 24-hour ABPM should be more utilized for diagnosis and treatment of HTN (in agreement with the Canadian Guidelines for Diagnosis and Management of Hypertension and guidelines by other national professional organizations).
Conclusions

24-hour ABPM is crucial for:

*Diagnosis and management of white-coat HTN and white coat effect*

*Diagnosis and management of masked HTN*

*Diagnosis of sleep HTN and detection of abnormal nocturnal patterns of BP*
Conclusions

‘If treatment aims at lowering blood pressure to a “normal”, clearly it is desirable to lower it to that level throughout the 24-hour cycle’.

24-hour ABPM is a much stronger predictor of CV morbidity and mortality than conventional measurement, and evidence is growing that nocturnal BP measured by ABPM may be the most sensitive predictor of CV outcome, from which it follows that the measurement of night-time BP should be an important part of clinical practice.