NOCTURNAL HYPERTENSION; CHRONOTHERAPY FOR HYPERTENSION

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Pediatric Nephrology
Kidneys for Life: Stop Acute Kidney Injury

www.worldkidneyday.org
Objectives:

1- Review the significance of hypertension for long-term morbidity and mortality (end-organ damage).

2- Review the 24 hours ABPM technique and diagnostic criteria.

3- Recognize the different patterns of nocturnal hypertension.

4- Critically analyze some of the milestone findings in the literature which suggest nocturnal hypertension is an independent predictor of worse CV outcomes.

5- Recognize that adequate treatment of nocturnal hypertension may improve CV outcomes for our patients.
Case

- 18 y old white female, otherwise healthy
- Coming in with multiple documentations of elevated BP readings.
- Asymptomatic.
- Athlete, plays soccer and softball
- No medications
- No significant past medical history
- Denies creational drug use
- Pregnancy test: negative
- **BP: 158/96, 164/104, 146/92 mmHg**
- W: 54 kg, H: 170 cm
- Physical Exam : all normal
Clinically relevant questions

- Is the documented blood pressure elevated for the patient?
- Is there documentation of persistently elevated blood pressures in otherwise healthy state?
- Does the blood pressure remain elevated in non-office settings (white coat hypertension)?
- Is there any end-organ damage?
- Do we need to determine the etiology (Primary vs. secondary)?
- How do we treat the patient with hypertension?
**Significance**

- **Hypertension** affects one quarter of the adult population worldwide.
- 60 million patients in USA
- One of the leading causes of death worldwide
- One of the most common causes for outpatient doctor’s visits.
- It is under-diagnosed,
- Untreated OR undertreated
Hypertension is the most important single treatable risk factor for the prevention of:

- Coronary heart disease
- Congestive heart failure
- Peripheral vascular disease
- Aortic dissection
- Stroke
- Chronic kidney disease / End-stage renal disease

In the adult world.
## Definition of HTN:

<table>
<thead>
<tr>
<th></th>
<th>Adults</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal</strong></td>
<td>&lt;120/80</td>
<td>&lt; 90\textsuperscript{th} %</td>
</tr>
<tr>
<td><strong>Prehypertension</strong></td>
<td>120-139/80-89</td>
<td>90\textsuperscript{th} - 95\textsuperscript{th} %#</td>
</tr>
<tr>
<td><strong>Stage 1 HTN</strong></td>
<td>140-159/90-99</td>
<td>95\textsuperscript{th}% - (99\textsuperscript{th}% + 5)*</td>
</tr>
<tr>
<td><strong>Stage 2 HTN</strong></td>
<td>&gt; 160/100</td>
<td>&gt; 99\textsuperscript{th}% + 5*</td>
</tr>
</tbody>
</table>
Table 2: 95th percentile for systolic and diastolic blood pressure for boys and girls

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Boys</th>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Height percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5th</td>
<td>25th</td>
<td>75th</td>
<td>95th</td>
<td>5th</td>
<td>25th</td>
<td>75th</td>
</tr>
<tr>
<td>Systolic, mm Hg</td>
<td>6</td>
<td>109</td>
<td>112</td>
<td>115</td>
<td>117</td>
<td>108</td>
<td>110</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>114</td>
<td>113</td>
<td>121</td>
<td>123</td>
<td>116</td>
<td>117</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>121</td>
<td>124</td>
<td>128</td>
<td>130</td>
<td>121</td>
<td>123</td>
<td>126</td>
</tr>
<tr>
<td>Diastolic, mm Hg</td>
<td>6</td>
<td>72</td>
<td>73</td>
<td>75</td>
<td>76</td>
<td>71</td>
<td>72</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>77</td>
<td>79</td>
<td>80</td>
<td>82</td>
<td>77</td>
<td>77</td>
<td>79</td>
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<tr>
<td></td>
<td>13</td>
<td>79</td>
<td>81</td>
<td>83</td>
<td>84</td>
<td>80</td>
<td>81</td>
<td>82</td>
</tr>
</tbody>
</table>
The image shows a graph illustrating the 5-year CVD risk per 100 people for different factors such as systolic blood pressure, total cholesterol, smoking status, HDL cholesterol, gender, diabetes status, and age. The x-axis represents the factors, and the y-axis indicates the percentage risk. The graph uses bars of varying colors and heights to depict the risk levels for each condition.
Underdiagnosis of Hypertension in Children and Adolescents
Hansen ML, Gunn PW, Kaelber DC. JAMA 2007 (298):874-879

- A cohort study including 14,187 children and adolescents
- Age 3-18 years old
- Observed at least 3 times for well-child care
- Between June 1999 and September 2006
- Single center in Ohio
- **Outcome parameter:** What proportion of the subjects with 3 or more hypertensive or prehypertensive BP measurements were actually documented as **hypertensive or prehypertensive** in the electronic medical records.
Underdiagnosis of Hypertension in Children and Adolescents

Hansen ML, Gunn PW, Kaelber DC. JAMA 2007 (298):874-879

- 507 subjects were hypertensive (3.6%) at 3 or more recordings during a well-child visit.
- Only 131 (26%) were documented in the medical records.
- 485 children were pre-hypertensive.
- Only 55 (11%) were documented.
- Patient factors that increased the adjusted odds of a correct diagnosis were:
  - 1- Older child
  - 2- >3 elevated BP readings
  - 3- Taller kids
  - 4- Obesity-related diagnosis
  - 5- Stage 2 hypertension
How well do we control hypertension?
Blood pressure variability during the day

Baguet JP. Integrated blood pressure control 2012:5; 27-34
Ambulatory Blood Pressure Monitor
Normal and Abnormal circadian patterns of blood pressure
Analysis of Ambulatory BP monitoring

- **Average (Mean) BP values**
  - 24 hours, awake, sleeping
- **BP load**
  - Systolic, diastolic /Awake, sleeping
- **Night-time dipping**
- **BP index**
Ambulatory BP monitoring
Interpretation criteria-

- **Mean BP;** Average of all the obtained systolic and diastolic readings
- **Awake** Mean Systolic / Diastolic BP
- **Sleeping** Mean Systolic / Diastolic BP
Ambulatory BP monitoring
Interpretation criteria-II

- **The blood pressure load**: the values detected to be above threshold BP value or 95\textsuperscript{th} percentile throughout the study.

- **Elevated BP load**: >30\% of all BP readings above (awake 135/85 mmHg) or 95\textsuperscript{th} percentile.

- **Normal BP load**: <25\% of all BP readings above (sleep 120/70 mmHg) or 95\textsuperscript{th} percentile.
Ambulatory BP monitoring
Interpretation criteria-III

- **Normal circadian BP pattern**: a fall in BP of at least 10% while sleeping.
- **Night-time dipping**: A fall in mean BP by at least 10% from day-time BP.
- **Non-dipping pattern**: a fall of <10%, associated with hypertensive end-organ injury.
- Kids: ESRD, renal transplant, IDDM
Normal and Abnormal circadian patterns of blood pressure
Figure 1

Figure 1. Nocturnal fall in systolic (SBP) and diastolic blood pressure (DBP) in population studies. Horizontal lines indicate the smallest systolic (full) and diastolic blood pressure (dashed) fall in the European populations. Mean values for systolic and diastolic fall at night are given above the bar for each of these studies. BPS indicates Belgian population study; EPOGH, European Project on Genes in Hypertension; AIB, Allied Irish Bank study; and PAMELA, The Italian Pressioni Arteriose Monitorate e Loro Associazioni. Reproduced with permission from Wang et al.17
Ambulatory BP monitoring

Interpretation criteria-IV

- **Blood pressure index**: Mean BP value divided by patient’s threshold for HTN or 95\(^{th}\) percentile
- Daytime Mean BP: 150/90 mmHg
- Threshold for HTN: 135/85 mmHg
- **Systolic BP index** = \(\frac{150}{135} = 1.1\)
- **Diastolic BP index** = \(\frac{90}{85} = 1.1\)
- Example: 1.1 BP index; 10% above 95\(^{th}\) percentile
Analysis of Ambulatory BP monitoring

- **Average (Mean) BP values**
  - 24 hours, awake, sleeping

- **BP load**
  - Systolic, diastolic /Awake, sleeping

- **Night-time dipping**

- **BP index**
24 hour Ambulatory Blood Pressure Monitoring

A: Diabetic patient referred for baseline study
   Normal ABPM study

B: Patient referred for refractory hypertension
   White coat hypertension

*Goldman: Cecil’s Textbook of Medicine 23rd edition, 2007*
## Diagnosing Blood Pressure patterns using 24 ABPM

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Mean BP readings Daytime</th>
<th>Mean BP readings Night-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambulatory normotension</td>
<td>&lt; 135 / 85 mmHg</td>
<td>&lt; 120 / 70 mmHg</td>
</tr>
<tr>
<td>Isolated daytime hypertension</td>
<td>&gt;135 / 85 mmHg</td>
<td>&lt; 120 / 70 mmHg</td>
</tr>
<tr>
<td>Isolated night-time hypertension</td>
<td>&lt; 135/ 85 mmHg</td>
<td>&gt; 120/70 mmHg</td>
</tr>
<tr>
<td>Day &amp; Night Sustained hypertension</td>
<td>&gt; 135/ 85 mmHg</td>
<td>&gt; 120 / 70 mmHg</td>
</tr>
</tbody>
</table>
White Coat Hypertension

- The blood pressure will be persistently *elevated* (>140/90 mmHg) if measured by a *doctor* or a *nurse*.
- But will be *normal* if the readings are obtained *outside* the medical office (<130/80 mmHg).
- Home blood pressure monitoring.
- 24 hour ambulatory blood pressure monitoring.
- It is relatively frequent. *30-40%* of the patients diagnosed as *hypertensive by office-BP readings* will have normal out of office BP readings.
White Coat Hypertension

- More common in women
- Unlikely to be influenced by ethnicity.
- Increases substantially with age.

**Pathogenesis:**
- 1- Hyperadrenergic state with increased sympathetic activity.
- 2- Impaired baroreflex of vagal cardiovascular drive
White Coat Hypertension

- Is white coat hypertension truly benign?
- Can WCH be a precursor to systemic hypertension?
- Does WCH cause end-organ damage?
Probability of white coat hypertension

Sorof JM, et al. AJH. 2001;14:855-860
White Coat Hypertension


235 consecutive subjects

137 untreated patients with essential hypertension

98 healthy normotensive subjects (Group A)

All evaluated with 24-hour ABPM.

Group B: hypertensive patients with nocturnal dipping >10% (82 patients)

Group C: hypertensive patients, non-dippers <10% (55 patients)

The prevalence of LVH in the hypertensive group was 14.6% (LV mass index > 120 g/m2).
Reproducibility of BP pattern
Dipper vs. non-dipper hypertensive patients
LV mass index

- LV mass index correlated better with:
  - 1- Night-time systolic and diastolic BP
  - Better than
  - 2- Day-time systolic and diastolic BP’s
  - 3- Casual systolic and diastolic BP’s

- LV mass index was significantly higher in the hypertensive non-dipper group (p=0.002)
Comparison of LV mass index between groups
Hypertensives; dipper vs. non-dipper

- **Non-dipper hypertensives** were older than the dipper hypertensives (50.7y vs. 55.2y, p=0.03)
- **No difference** for the below criteria between groups:
  - Casual BP
  - Ambulatory daytime systolic and diastolic BP
  - Gender
  - Body surface area
  - Duration of hypertension
  - Prevalence of diabetes
  - Funduscopic changes
  - Serum creatinine
  - Quantity of sleep during monitoring
LV mass index and BP dipping

- A statistically significant inverse correlation was found between LV mass index and percentage of nocturnal reduction (night-time dipping) of daytime systolic (p<0.001) and diastolic (p<0.001) BP.
- The less the nocturnal BP dipping, the bigger the LV mass index
Ambulatory Blood Pressure

An Independent Predictor of Prognosis in Essential Hypertension

Paolo Verdecchia, Carlo Porcellati, Giuseppe Schillaci, Claudia Borgioni, Antonella Ciucci,

- 1187 patients with essential hypertension
- 205 healthy normotensive controls
- Cross-sectional evaluation with 24 ABPM
- At baseline, off-therapy
- Mean follow-up of 3.2 years (up to 7.5 years).
- No follow-up studies for 24 ABPM

**Primary outcome**: Cardiovascular morbidity and mortality
- Prevalence of white coat hypertension ; 19.2%
- Mask hypertension is not reported
Cardiovascular morbidity

Cardiovascular morbidity

- Normotensive = white coat hypertension
- Compared to subjects with WCH;
- CV morbidity increased in subjects with ambulatory hypertension with nocturnal dipping (relative risk 3.70).
- The risk further increased for hypertensive non-dipper subjects (relative risk 6.26).
Probability of event-free survival

LV mass index

ABPM vs. Cardiac ECHO

- Ambulatory blood pressure (nocturnal BP dipping) may stratify long-term cardiovascular risk in essential hypertension more accurately than ECHO LV hypertrophy.
<table>
<thead>
<tr>
<th>Covariate</th>
<th>Relative Risk (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV hypertrophy at echocardiography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present vs absent</td>
<td>1.82 (1.02-3.22)</td>
<td>.039</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;60 vs &lt;40 y</td>
<td>8.04 (1.89-34.24)</td>
<td>.004</td>
</tr>
<tr>
<td>40-60 vs &lt;40 y</td>
<td>2.17 (0.50-9.28)</td>
<td>.29</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men vs women</td>
<td>4.16 (1.52-11.33)</td>
<td>.005</td>
</tr>
<tr>
<td>Dipping pattern, nondippers vs dippers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>1.04 (0.49-2.17)</td>
<td>.91</td>
</tr>
<tr>
<td>Women</td>
<td>6.79 (2.45-18.82)</td>
<td>.0002</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; LV, left ventricular.
Event-free survival: Dippers vs. Non-dippers

Substudy to the Systolic hypertension in Europe (Syst-Eur) Trial
- 808 older patients (>60 years old)
- Baseline office BP 160-219 / <95 mmHg
- Systolic hypertension
- Randomization: Nitrendipine vs placebo
- Addendum as clinically needed; Enalapril and/or hydrochlorothiazide

Primary end-points:
1. Total and cardiovascular mortality & other endpoints
2. Total and nonfatal stroke

Independent predictors of CV endpoints / placebo

CV endpoints in the placebo group

1542 patients, >40 years old
- Evaluated by 24 ABPM at baseline
- Mean follow-up of 5.1 years
- Divided into groups according to their level of nocturnal dipping
- No intervention in the study design.
- Patients received antihypertensive therapy as their physician’s decision

Different nocturnal dipping groups

![Diagram showing different categories of nocturnal decline in DBP and SBP.]

**FIGURE 1. Categorization of subjects according to the nocturnal decline in DBP and SBP.**

Cox proportional hazards regression model was adjusted for:
- Age
- Gender
- Smoking status
- Previous history of CV disease
- Antihypertensive treatment

**Outcome:**
- 1- The mortality risk was highest in inverted dippers and non-dippers.
- Same pattern was observed whether the patients are treated or non-treated.
- Cardiovascular mortality outnumbered non-CV causes.

Baseline nocturnal dipping and overall mortality

FIGURE 2. Kaplan-Meier survival curves showing the relationship between the baseline nocturnal decline in BP and overall mortality. Dashed line, extreme dippers; solid line, dippers; heavy solid line, nondippers; dotted line, inverted dippers.
Why would night-time BP profile be more important than daytime or overall average?

1- Night-times may be more homogenous in activity / excitement levels (most of us sleep). Therefore, any diversion from normal may be more meaningful.

2- It might be a 8-10 hours break from the wear and tear of hypertension on the CV system. If one loses that, there might simply be more damage due to persistently elevated BP.
<table>
<thead>
<tr>
<th>Category of ambulatory blood pressure</th>
<th>Daytime</th>
<th>Nighttime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambulatory normotension</td>
<td>&lt;135/85</td>
<td>&lt;120/70</td>
</tr>
<tr>
<td>Isolated daytime hypertension</td>
<td>≥135/85</td>
<td>&lt;120/70</td>
</tr>
<tr>
<td>Isolated nocturnal hypertension</td>
<td>&lt;135/85</td>
<td>≥120/70</td>
</tr>
<tr>
<td>Day–night sustained hypertension</td>
<td>≥135/85</td>
<td>≥120/70</td>
</tr>
</tbody>
</table>

Isolated nocturnal hypertension was defined as a nighttime blood pressure of $\geq 120$ mm Hg systolic or $70$ mm Hg diastolic and a daytime blood pressure $<135/85$ mm Hg; and isolated daytime hypertension as a daytime blood pressure of $\geq 135$ mm Hg systolic or $85$ mm Hg diastolic and a nighttime blood pressure $<120/70$ mm Hg.

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Isolated Nocturnal Hypertension (%)</th>
<th>Isolated Daytime Hypertension (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asians</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese (n=677)</td>
<td>10.9</td>
<td>4.9</td>
</tr>
<tr>
<td>Japanese (n=1038)</td>
<td>10.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Europeans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East (n=854)</td>
<td>7.9</td>
<td>13.9</td>
</tr>
<tr>
<td>West (n=3268)</td>
<td>6.0</td>
<td>9.1</td>
</tr>
<tr>
<td>South Africans (n=201)</td>
<td>10.2</td>
<td>6.6</td>
</tr>
</tbody>
</table>
A  Total mortality

- Normotension
- Isolated daytime hypertension
- Isolated nocturnal hypertension
- Sustained hypertension

B  CV events

\( P < 0.0001 \)

\( P < 0.0001 \)

Years of follow-up

Li, Yan; Wang, Ji-Guang. Hypertension. 61(2):278-283, February 2013.
Normal and Abnormal circadian patterns of blood pressure

Ingilfinger J. NEJM 2002; 347: 778-779
Influence of Circadian Time of Hypertension Treatment on Cardiovascular risk: MAPEC Study

- Prospective trial
- 2156 hypertensive subjects
- Mean age 55.6 years
- Randomization:
  - **Group 1:** Patients taking all their antihypertensive doses in the morning
  - **Group 2:** Patients taking at least one of the antihypertensive doses at night-time.
- **Research hypothesis:** Bedtime chronotherapy with 1 or more antihypertensive doses at night-time will produce better BP control and reduced CV risk when compared to taking all anti-hypertensives in the morning.

Influence of Circadian Time of Hypertension Treatment on Cardiovascular risk: MAPEC Study

- All BP assessments were done by 48 ABPM.
- Physical activity was recorded by wrist actigraphy.
- Scheduled BP assessment was completed annually.
- Quarterly assessment if treatment adjustment was required.
- Median follow-up of 5.6 years.

Influence of Circadian Time of Hypertension Treatment on Cardiovascular risk: MAPEC Study

- **Inclusion criteria:**
  1. Untreated hypertension
  2. Poorly controlled hypertension despite treatment
  3. Treated hypertensives were included after a 2 weeks wash-out period.

Hypertension diagnosis was based on the ABPM criteria.

MAPEC Study *did not specify or require a unique anti-hypertensive medication* to be used.

Participating physicians had the liberty to choose the medications for their patients.
Assessed for eligibility (n = 2312)

Enrollment

Excluded (n = 111; invalid ABPM evaluation at baseline)
Included (n = 2201)

Allocated to treatment upon awakening (n = 1109)

Allocation

Lost to follow-up (n = 25) (<6 months of required follow-up)

Follow-Up

Lost to follow-up (n = 20) (<6 months of required follow-up)

Analysis

Analized (n = 1084)

Analized (n = 1072)
MAPEC Study; Results

- There was **no difference** in ambulatory BP between groups at **baseline**.
- At the final evaluation;
- Subjects ingesting **at least one of the antihypertensive medications at bedtime showed**:
  1. Lower mean sleep time BP
  2. Higher nocturnal BP dipping
  3. Reduced prevalence of non-dipping (34% vs. 62%, p<0.001)
  4. Higher prevalence of controlled ambulatory BP (62% vs. 53%, p<0.001)

MAPEC Study; Results

- Subjects ingesting at least one of the antihypertensive medications at bedtime exhibited:
  - 1- Significantly lower relative risk of total CVD events (187 events vs. 68, p<0.001)
  - 2- Significantly less major CVD events (death, MI, ischemic stroke, hemorrhagic stroke) (55 events vs. 18 events, p<0.001)

- The most significant predictors of event-free survival were:
  - 1- The amount of decrease in nocturnal BP (from baseline)
  - 2- The increase in nocturnal BP % dipping.

**REMEMBER:** Both can only be evaluated by 24 ABPM.
Significance

- **Hypertension** affects one quarter of the adult population worldwide.
- 60 million patients in USA
- One of the leading causes of death worldwide
- One of the most common causes for outpatient doctor’s visits.
- It is under-diagnosed,
- Untreated OR undertreated
Significance

- **Hypertension** is the most important single treatable risk factor for the prevention of:
  - Coronary heart disease
  - Congestive heart failure
  - Peripheral vascular disease
  - Aortic dissection
  - Stroke
  - Chronic kidney disease / End-stage renal disease

In the adult world.
Hypertension is a killer

- **Pre-hypertension** is not benign.
- **Systolic hypertension** is not benign.
- **Masked hypertension** is definitely not benign.
- **White coat hypertension** may not be benign.
- **Nocturnal hypertension** is clearly a killer.
- Hypertension is **under-diagnosed** and **sub-optimally treated**.
Boiling frog analogy of hypertension
Suggested changes for your practice

- The **loss or reversal of nocturnal BP dipping** is a surrogate marker for worse CV outcomes.
- Adequate treatment for hypertension should recognize the whole **24 hour BP profile** and aim to restore the normal profile.
- **Isolated nocturnal hypertension** is as common as isolated daytime hypertension.
- **24 ABPM** is the only tool to diagnose and follow nocturnal BP pattern abnormalities.
- Giving at least some of the **antihypertensive medication doses at night-time** may provide survival advantage to our patients.
Why is home BP monitoring not enough?

Office Blood pressure readings

Home Blood pressure monitoring

24 ABPM

Because only 24 ABPM can give us the nocturnal BP profile.
24 ABPM in Merlin

- 1- Order Entry
- 2- amb bp (pediatric / adult)
- Diagnosis: elevated blood pressures
- Send the patient to ECG lab, third floor Ruby Memorial Hospital
- Insurance coverage:
  - Most cover the test if on no medication
  - Most do not cover if already on treatment
  - Adjusted cost $80 is billed to patients whose insurance does not cover the testing (vs. $350)
Kidneys for Life: Stop Acute Kidney Injury
www.worldkidneyday.org
Nocturnal Hypertension; Chronotherapy for Hypertension

We thank you for your attention.

Saving the world, One mmHg at a time...

www.kidneyessentials.com
Prognostic Value of Ambulatory Blood-Pressure Recordings in Patients with Treated Hypertension

Denis L. Clement, M.D., Ph.D., Marc L. De Buyzere, B.Sc.
Hourly Means of Systolic and Diastolic Blood Pressure Derived from 24-Hour Ambulatory Blood-Pressure Recordings Obtained at Base Line (Visit 3) in the 1963 Participants.

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<tr>
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<tbody>
<tr>
<td><strong>Office blood pressure (mm Hg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>148±18</td>
<td>165±21</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic</td>
<td>91±10</td>
<td>96±12</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Ambulatory blood pressure (mm Hg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24-Hr systolic</td>
<td>123.5±7.7</td>
<td>148.8±11.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>24-Hr diastolic</td>
<td>78.8±8.2</td>
<td>90.2±11.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Daytime systolic</td>
<td>128.8±9.2</td>
<td>153.7±12.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Daytime diastolic</td>
<td>83.8±9.1</td>
<td>94.8±11.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nighttime systolic</td>
<td>113.2±10.4</td>
<td>138.0±15.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nighttime diastolic</td>
<td>69.8±9.6</td>
<td>81.4±12.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ratio of nighttime systolic to daytime systolic</td>
<td>0.88±0.09</td>
<td>0.90±0.09</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ratio of nighttime diastolic to daytime diastolic</td>
<td>0.84±0.10</td>
<td>0.86±0.11</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Incidence of Cardiovascular Events According to Category of Office Systolic Blood Pressure.

Hypertensive patients

Population studies

Predictive Role of the Nighttime Blood Pressure.
Hansen, Tine; Li, et al.